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VERBAL LEARNING AS A FUNCTION OF TYPE OF MNEMONIC TECHNIQUE AND WORD ABSTRACTNESS

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Verbal Learning as a Function of Type of Mnemonic Technique and Word Abstractness", submitted by Dennis Larry Foth in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

This study was designed to extend our present knowledge of the effectiveness and capabilities of mnemonic techniques and to relate such findings to the recent theoretical considerations pertaining to verbal and imaginal mediation processes in associative learning and memory.

Two hundred subjects were assigned to one of 10 conditions comprising a 5 x 2 factorial arrangement. Each cell contained 20 subjects. One factor was defined by mnemonic instructional set (rhyme-image mnemonic, rhyme-verbal mnemonic, hook-image mnemonic, stack-image mnemonic, and no mnemonic) and the other by to-be-recalled word abstractness (concrete and abstract nouns). Each subject received condition-appropriate instructions, practice with the appropriate mnemonic technique, and testing on each of two 10-item word lists during a training session. One week later, each subject received one study-test trial on each of five 10-item word lists. This was followed by a final recall test for all words presented during this testing session. A post-experimental questionnaire was administered at the end of this session.

The major findings were: (a) concrete words were significantly better recalled than abstract words; (b) mnemonic training resulted in significantly better recall of concrete words relative to a non-mnemonic control group when specific within-list order information was demanded - no such differences were found for groups presented abstract words; (c) verbal and imaginal instructional sets did not differentially affect

recall of either concrete or abstract words; (d) no significant differences existed among the three imagery-based mnemonic techniques; (e) significantly better recall for the imagery-based mnemonic techniques when the mnemonic word cue stimulus terms were explicitly presented on a study-test trial relative to the true mnemonic situation in which the subject himself must implicitly provide such terms; (f) no apparent facilitation of mnemonic techniques on retention (final recall test); and, (g) significant non-differential loss of previously acquired associations for all mnemonic and non-mnemonic groups (final recall test).

These findings indicated that some of the claims made in regard to the overall utility of mnemonic techniques are unfounded. In addition, the recent theory of verbal and imaginal mediation processes in associative learning and memory (Paivio, 1969), based essentially on investigations of the standard paired-associate situation, does not appear to fully account for the results obtained in this investigation. Although the reasons for this cannot be precisely specified at this time, it does seem clear that the functional differences between the mnemonic and paired associate tasks are based on the nature of the stimulus terms (implicit and explicit, respectively) and, related to this, the utilization of these stimulus terms as retrieval cues at recall.

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CHAPTER 1

Introduction

Mnemonic (memory training) techniques, supposedly capable of improving a person's memory, have existed for almost 2500 years (Yates, 1966). At the present time these techniques are popular with the general public in terms of demonstrations of extraordinary memory feats (i.e., entertainment value - cf. Luria, 1968; Weinland, 1957) and in terms of claims regarding "success in life, love, school, and business" (Bower, 1970b, p. 496), supposedly occurring as a result of improved memory "power", made by the advocates of such techniques. A number of mnemonic techniques are available to the public through commercial memory courses (e.g., Furst, 1957) and through "self-help" books on memory improvement which can be found in most bookstores (e.g., Hayes, 1958; Weinland, 1957).

Despite the long history, apparent popularity, and availability of these mnemonic techniques, investigations into the effectiveness and processes involved in such techniques have been, until very recently, essentially nonexistent. The reasons given to account for this lack of interest in mnemonic techniques by psychologists are varied. Norman (1969), for example, suggests that most psychologists have been unwilling to investigate mnemonic techniques because of the difficulties associated with such research and because of the belief that the basic principles underlying learning via the mnemonic technique are the same as those underlying

rote learning. Bower (1970b) suggests that respectable investigators may have been deterred from investigating mnemonic techniques because such techniques are unrespectably advertised in the back pages of newspapers and pulp magazines. Paivio (1969) suggests that Watson's (1913) rejection of mentalistic concepts resulted in an emphasis on processes which were not compatible with processes presumed to be involved in the utilization of mnemonic techniques.

All of the above reasons are undoubtedly true to some extent. However, an alternative, and perhaps more accurate, explanation is that until very recently theoretically relevant questions regarding the processes involved in mnemonic techniques could not be asked. For example, some type of mediational process, presumably nonverbal in nature, appears to be involved in the utilization of a mnemonic technique. However, it has only been in the past fifteen years that verbal mediational processes have been subject to serious theoretical and empirical scrutiny in associate learning (e.g., Russell and Storms, 1955; Jenkins, 1963; cf. Kjeldergaard, 1968) and only in the past nine years that nonverbal mediational processes (i.e., imagery) have been similarly considered (e.g., Paivio, 1963; cf. Reese, 1970). The point is that questions relating to mnemonic techniques have only become meaningful at this time as a result of psychologists' continuing attempts to determine the type and the nature of the processes involved in associative learning and memory.

In order to demonstrate that mnemonic techniques can result in efficient associative learning and to provide an overview of just what is involved in the learning and utilization of a mnemonic

technique, an anecdote taken from a book by Miller, Galanter, and Pribram (1960) is presented below. The implication inherent in the anecdote is that learning by a mnemonic technique is more efficient, both in terms of time and repetitions of the material, than is the method of rote memorization.

> "One evening we were entertaining a visiting colleague, a social psychologist of broad interests, and our discussion turned to Plans. 'But exactly what is a Plan?' he asked. 'How can you say that memorizing depends on Plans?'
>
> 'We'll show you,' we replied. 'Here is a Plan that you can use for memorizing. Remember first that:
>
> one is a bun,
> two is a shoe,
> three is a tree,
> four is a door,
> five is a hive,
> six are sticks,
> seven is heaven,
> eight is a gate,
> nine is a line, and
> ten is a hen.'
>
> 'You know, even though it is only ten-thirty here, my watch says one-thirty. I'm really tired, and I'm sure I'll ruin your experiment.'
>
> 'Don't worry, we have no real stake in it.' We tightened our grip on his lapel. 'Just relax and remember the rhyme. Now you have part of the Plan.
>
> The second part works like this: when we tell you a word, you must form a ludicrous or bizarre association with the first word in your list, and so on with the ten words we recite to you.'
>
> 'Really, you know, it'll never work. I'm awfully tired,' he replied.
>
> 'Have no fear,' we answered, 'just remember the rhyme and then form the association. Here are the words:

1. ashtray,
2. firewood,
3. picture,
4. cigarette,
5. table,
6. matchbook,
7. glass,
8. lamp,
9. shoe,
10. phonograph.'

> The words were read one at a time, and after reading the word, we waited until he announced that he had the association. It took about five seconds on the average to form the connection. After the seventh he said that he was sure the first six were already forgotten. But we persevered.
>
> After one trial through the list, we waited a minute or two so that he could collect himself and ask any questions that came to mind. Then we said, 'What is number eight?'
>
> He stared blankly, and then a smile crossed his face. 'I'll be damned,' he said. 'It's lamp.'
>
> 'And what number is cigarette?'
>
> He laughed outright now, and gave the correct answer. 'And there is no strain,' he said, 'absolutely no sweat.'
>
> We proceeded to demonstrate that he could in fact name every word correctly, and then asked, 'Do you think that memorizing consists of piling up increments of response that accumulate as the words are repeated?' The question was lost in his amazement." (pp. 134-136)

Miller *et al.*'s visitor learned the list of words after only a single presentation of each item. In addition, his "study time" (not counting the learning of the mnemonic rhyme) was approximately fifty seconds. A ten-item list of high meaningfulness stimulus and response words in a standard paired associate task may take, on the average, nine trials (each pair presented once on each trial) before every response word can be correctly given to every stimulus word (e.g., Cieutat, Stockwell, and Noble, 1958). Assuming a two-

second "study time" per item on each trial, one hundred and eighty seconds, or approximately three and one-half times as much time is required in the standard paired-associate task as compared with the mnemonic task to learn a ten-item list of words. It is factors such as this time differential between these two tasks and the present emphasis in some quarters (e.g., Bower, 1970b; Paivio, 1969) on nonverbal mediational processes in association learning and memory which indicate the need for investigations into mnemonic techniques per se. Specifically, investigations of the variables and processes which distinguish mnemonic methods from other verbal learning methods and an assessment of the capabilities of such mnemonic methods may provide further insight into processes involved in associative learning in general.

A number of studies have already been carried out in an effort to assess the utility of mnemonic methods as well as some of the variables presumed operative in such methods (e.g., Bugelski, 1968; Delin, 1969a; Smith and Nobel, 1965; Wood, 1967). As with any new area of investigation, however, the results of these initial studies have been somewhat inconsistent and of limited generality for the usual reasons (e.g., lack of adequate control groups, differential training with the mnemonic techniques, differing presentation methods, etc.). What does appear to be fairly well substantiated, however, is that the learning of relatively concrete words (e.g., house) following training with a mnemonic technique which emphasizes some form of imaginal mediation is superior to traditional rote learning procedures.

This thesis is an attempt to extend our present knowledge regarding the effectiveness and capabilities of mnemonic techniques. In addition, it attempts to relate such findings to recent theoretical considerations pertaining to verbal and imaginal mediational processes in associative learning and memory - considerations largely based on an analysis of these processes in the standard paired-associate learning task (Paivio, 1969). Specifically, the thesis is concerned with: determining the suitability of mnemonic techniques for learning words that are relatively abstract (e.g., fate); determining whether imagery mediation is the necessary condition for mnemonic technique effectiveness; determining what differences, if any, exist between mnemonic techniques which form the basis of three commercially available memory courses; and, determining the capabilities of mnemonic techniques in terms of the application of the same mnemonic technique to successive lists of words.

Mnemonics

Traditionally, the term "mnemonic" has been regarded as referring to any device or system suspected of enhancing an individual's "natural memory" (Young, 1961). In this paper, however, it exclusively refers to a formally organized system involving a previously learned set of word cues and an instructional set to form either image (in the sense of "mental pictures") or verbal associations between such word cues and the to-be-remembered words. This restriction does limit consideration to those mnemonic techniques

that are publicly available as commercial memory courses and to those described in the "self-help" books. The restriction is not meant to deny either the existence or usefulness of such mnemonic devices as natural language mediators (Montague, Adams, and Kiess, 1966) or the idiosyncratic devices and schemes an individual might employ when confronted with a verbal learning task (e.g., Runquist and Farley, 1964). However, such mnemonic devices do not appear to enable a person to perform the extraordinary memory feats that training with a mnemonic technique is supposedly capable of.

Early History. The invention of the first mnemonic technique is credited to the Greek poet Simonides (*circa* 500 B.C.). Although none of Simonides' writings exist today, the English historian, Frances A. Yates, has presented, in translation, the original sources which first referred to this memory technique in her book, *The Art of Memory*. Much of what follows concerning the history and development of mnemonic techniques up to the Seventeenth Century is based on this source.

The idea of a mnemonic system for use in rhetoric is described as having occurred to Simonides as a result of a personal experience. During the course of a banquet to which Simonides had been invited, the roof of the banquet hall collapsed killing all of the guests with the exception of Simonides, who had been called outside just prior to the tragic event. Due to the magnitude of the disaster it was found impossible to identify the remains of the guests. Simonides,

however, was familiar with the names of all the guests and was also able to remember where they had been seated at the banquet tables. Hence, he was able to identify them. Realizing that "the order of places preserved the order of things and that the images of things denoted the things themselves" (Yates, 1966, p. 4), Simonides subsequently "invented" the first mnemonic technique. This technique, usually referred to as the place-image system, consisted of rules for the selection of places (memory loci) and images. The basic rules for the selection of places are found in an anonymous work entitled Ad Herennium and are reported by Yates. These rules included the following:

> "A locus is a place easily grasped by memory, such as a house, an intercolumnar space, a corner, an arch, and the like ....
>
> If we wish to remember much material we must equip ourselves with a large number of places. It is essential that the places should form a series and must be remembered in their order, so that we can start from any locus in the series and move either backwards or forwards from it .... If these have been arranged in order, the result will be that, reminded by the images, we can repeat orally what we have committed to the loci, proceeding in either direction from any locus we please.
>
> The formation of the loci is of the greatest importance, for the same set of loci can be used again and again for remembering different material. The images which we have placed on them for remembering one set of things fade and are effaced when we make no further use of them. But the loci remain in the memory and can be used again by placing another set of images for another set of material. The loci are like wax tablets which remain ready to be written on again." (Yates, 1966, pp. 6-7)

The basic rules for the selection of images are also contained in the Ad Herennium and are quoted directly by Yates:

> "Now nature herself teaches us what we should do. When we see in every day life things that are petty, ordinary, and banal, we generally fail to remember them, because the mind is not being stirred by any thing novel or marvellous. But if we see or hear something exceptionally base, dishonourable, unusual, great, unbelievable, or ridiculous, that we are likely to remember for a long time. Accordingly, things immediate to our eye or ear we commonly forget; incidents of childhood we often remember best. Nor could this be so for any other reason than that ordinary things easily slip from the memory while the striking and the novel stay longer in the mind. A sunrise, the sun's course, a sunset are marvellous to no one because they occur daily. But solar eclipses are a source of wonder because they occur seldom, and indeed are more marvellous than lunar eclipses, because they are more frequent ....
>
> We ought, then to set up images of a kind that can adhere longest in memory. And we shall do so if we establish similitudes as striking as possible; if we set up images that are not many or vague but active; if we assign to them exceptional beauty or singular ugliness; if we ornament some of them, as with crowns or purple cloaks, so that the similitude may be more distinct to us; or if we disfigure them, as by introducing one stained with blood or soiled with mud or smeared with red paint, so that its form is more striking, or by assigning certain comic effects to our images, for that, too, will ensure our remembering them more readily. The things we easily remember when they are real we likewise remember without difficulty when they are figments. But this will be essential - again and again run over rapidly in the mind all the original places in order to refresh the images." (_Ad Herennium_, cited in Yates, 1966, pp. 9-10)

These two quotations describe the mnemonic technique in its pristine form. Numerous innovations, as will be evident, have been carried out on Simonides' place-image mnemonic system. However, the two basic principles have remained unaltered. That is, most subsequent mnemonic techniques, including all those used in present-day memory courses, utilize an ordered system of memory cues analogous to Simonides' memory loci (places) and instructions to form images, especially those that are active and bizarre or both, which link the

previously learned memory cues and the to-be-remembered material.

The assumption most important to the mnemonic technique *per se* is contained in the instruction to transform words to images and the images back to words. Specifically, memory for concrete objects is assumed to be superior to memory for words. Otherwise, there is no necessity to transform words to images at all (Paivio, 1969). It is this assumption that has provided the basis for much of the recent work into the effects of imagery in paired-associate learning (cf. Reese, 1970) as well as into the isolation of the variables presumed to be operative in learning after training with a mnemonic technique (e.g., Delin, 1969b). Before turning to a consideration of these investigations, however, it is necessary to briefly describe the evolution of Simonides' mnemonic technique to its present-day versions.

Development. Giordano Bruno (1548-1592) developed what was, and still is, the most extensive of all mnemonic techniques. Bruno's aim was to develop a mnemonic system which would enable a person to recall all the known facts of the universe. While this would appear to be a prodigious advance in the application of Simonides' technique, numerous innovations had already occurred which set the stage for this ambitious enterprise. Among the foremost of these was the memory technique of Ramon Lull (1235-1316). Lull had developed a mnemonic technique which was totally devoid of imagery. He used, instead, a system of revolving wheels, similar to those sometimes used today for determining the distance between two geographical locations, upon which concepts were desig-

nated by a system of letter notation. These combinatory wheels, as Lull called them, enabled one to interrelate a series of concepts and to recall them in an orderly fashion. Bruno adopted this system of combinatory wheels for use with subjects and predicates and tied the "locations" of such concepts to a complex organization of astrological images which were also placed upon the wheels. His memory system, therefore, had the potential for containing many more "bits" of information than did its predecessors. It suffered in terms of public acceptance for two reasons. First, it was obviously difficult to master and second, it was supposedly based on a form of Egyptian occultism and was therefore considered as a heretical doctrine by the Church of Rome. It was for this latter reason that Bruno was executed in 1592 and his later manuscripts on this very extensive mnemonic technique destroyed.

A number of other mnemonic techniques were developed about this time including Robert Fludd's "memory theatre" which used many of Bruno's innovations and memory loci based on Shakespeare's Globe Theatre. It was not until 1648, however, that the first major addition to Simonides' mnemonic technique which is included in most present-day mnemonic systems was made. This mnemonic technique was developed by Winckelmann (or Stanislaus von Mink as he is sometimes referred to) and was specifically designed for remembering numbers, especially dates (cf. Norman, 1969). Winckelmann's system consisted of using a specific consonant or consonants to represent a digit. Vowels, which had no numerical equivalents,

were then introduced appropriately between the consonants to form a word. For example, the date 1648 might be represented as the word "tadpole" with _t_ signifying the 1, _d_ for 6, _p_ for 4, and an _l_ for 8. Winckelmann's selection of consonants for numbers was apparently arbitrary although later systems took advantage of acoustic and visual similarity between the numbers and letters for these number-letter codes. Gregor von Fenaigle, a professional mnemonist, devised a mnemonic technique which essentially combined Simonides' place-image system with Winckelmann's number-letter-word mnemonic.

Fenaigle's mnemonic technique is described in _The New Art of Memory_, an apparently popular book written in 1813 by one of his students who does not identify himself. This mnemonic technique utilized a "memory house" which consisted of as many rooms as a person found necessary with 50 memory locations in each room. These memory locations were numbered and methods for transitions from room to room were also incorporated into the system. The truly novel innovation of Fenaigle's mnemonic technique, however, was in having an image associated with each memory location that was based on the number itself. For example, the image to be associated with the first memory location was the Tower of Babel, a swan was to be associated with the second memory location, and so on. To-be-remembered materials were then associated with these images. Retrieval of information followed the same rules as for Simonides' technique with the exception that the number alone could function as the initial memory cue as it led to the

image associated with the memory location and ultimately, to the information that one wished to recall.

Present-day Mnemonic Techniques. The increasing emphasis on the number-letter-word codes and decreasing emphasis on the representation in memory of actual physical locations (a street, a building, a chart, etc.) has led to the development of mnemonic techniques employing only numbers and words, often independent of a mediating letter. One such technique is known as the number-rhyme system. Its first formal expression was given by Sambrook in 1879 (cf. Paivio, 1971) although it is best known today as a result of a textbook on public speaking by Carnegie (1937) and through the attention given to it by Miller, Galanter, and Pribram (1960).

The number-rhyme-image mnemonic technique, or rhyme-mnemonic as it will be referred to, consists of an ascending series of cardinal numbers, 1, 2, 3, ..., n (depending on the length of the system desired), and words that rhyme with the numbers. Although any rhyming words might be utilized, Carnegie (1937) selected words denoting common objects which, obviously, could be readily visualized. For example, the rhyme word for one is gun, zoo for two, tree for three, etc. As was indicated in the Miller, Galanter, and Pribram anecdote, this number-rhyme word code is thoroughly memorized by the individual so that the number elicits the word and the word the number. Each to-be-remembered item is then associated with the visual representations of the rhyme words. For expository purposes consider the first three items of a grocery

list: bread, sugar, and coffee. For the first item, bread, a gun might be visualized by an individual as a howitzer and the loaf of bread as being inserted into the breech for firing. For the second item, sugar, an individual might visualize himself visiting a zoo and feeding sugar cubes to the animals. For the third item, coffee, an individual might visualize a tree similar to an apple tree but instead of apples, one-pound bags of coffee are hanging from the branches. At recall, the individual need only "prime" himself with the cardinal numbers which then elicit the associated rhyme word. The rhyme word "brings to mind" the corresponding image devised by the individual and subsequently, the grocery items which he is to purchase.

It should be noted that the rules for the formation of images for contemporary mnemonic techniques parallel those suggested by the author of the Ad Herennium. Essentially, images should involve action (feeding animals at the zoo), bizarreness (loading a loaf of bread into a gun breech), or novelty (coffee bags hanging in a tree). The advantage of the rhyme-mnemonic, compared with Simonides' place-image technique, would appear to be its simplicity in learning the code due to the phonetic similarities between the numbers and rhyme words. Some support for this has been obtained. For example, Bower and Bolton (1970) have demonstrated that the faster learning of rhyming associates (e.g., one-bun) relative to nonrhyming associates (e.g., one-cat) is due to the fact that the rhyming relation restricts the range of response alternatives to the stimulus, essentially converting recall into a recognition test.

While the rhyme-mnemonic is a modern version of the place-image system of Simonides, a contemporary mnemonic technique does exist which parallels Simonides' system more directly. It does, however, take advantage of the order information inherent in the cardinal number system. This mnemonic technique, developed by Hayes (1958), makes use of various parts of an automobile upon which or within which the to-be-remembered items can be placed or stacked. Once the various memory places (parts of the car) corresponding to the numbers have been memorized, e.g., one-hood, two-headlights, three-bumpers, etc., the principles for handling the to-be-remembered items are identical to the rhyme-mnemonic technique. For example, a loaf of bread may be visualized as dancing on the hood of the automobile, sugar cubes are stuffed into the headlights, and so on. At recall, it is only necessary to recall the number which in turn evokes the appropriate automobile location and finally, the item which is associated with it. In this paper, this version of the place-image system will be referred to as the stack-mnemonic.

Both the rhyme-mnemonic and the stack-mnemonic suffer in terms of limitations due to the number of different rhyme words or memory locations of the automobile that can be readily utilized. The practical limit seems to be about twenty items. A mnemonic technique which overcomes, to some extent, this limitation has been developed by Furst (1949, 1957). This system takes advantage of Winckelmann's number-letter code with the letters being utilized to form a series of "hook" words which are then treated in the same fashion as the words of the rhyme- and stack-mnemonic systems.

Because of Furst's description of these words as "hooks" this system will be referred to as the hook-mnemonic.

To use Furst's hook-mnemonic system, a person first must learn the alphabet equivalents for numbers. This number-letter code is based, in most cases, on the visual similarities between the cardinal numbers 0, 1, 2, ..., 9 and the alphabetic characters. For example one (1) is t because of the similar down-stroke, two (2) is n for rotating a 2 ninety degrees to the left makes it look like an n, and so on. Where no visual similarity exists, other "tricks" are used. For example, four (4) is r because the words fore, for, and four all contain an r. The fact that they also contain an f and an o does not appear to be troublesome as f is the letter equivalent for eight (8) and vowels are ignored in the code. Once the number-letter codes have been learned for 0, 1, 2, ..., 9, a word which starts with the letter is formed - a word that readily evokes some sort of image. For example, 1 is tea and a person visualizes a teacup within which to-be-remembered items may be placed, 2 is Noah and one visualizes placing to-be-remembered items in Noah's ark, and so on. For numbers larger than 9, combination rules are used. Ten (10) is toes, (zero is "defined" as s or z), eleven is tot, 314 is motor, and so on. The memory course based on this technique (Furst, 1957) usually provides one hundred "hook" words although the practical limits of such a system would seem to be a function of the individual's ingenuity in devising dissimilar word hooks and his skill in using them.

The advertising associated with commercial memory courses based on these mnemonic techniques and the popular "self-help" books available on this topic make numerous claims regarding the efficacy of such techniques in learning lists of words relative to rote learning methods. It is important to note that such claims are meant to apply only to those individuals who have mastered a particular mnemonic technique and who utilize it consistently. Unfortunately, the advertising does not make clear precisely what "mastering the technique" is beyond enrolling in the course and practising the principles. Included among these claims are: "perfect" recall after only one presentation of the material, "perfect" recall independent of the number of items (claims of 100 items or more are not uncommon), superior long-term retention (the period of time often being expressed in terms of months and years), freedom from the effects of interference within long lists of words, applicability to a wide range of materials (e.g., names of persons, grocery lists, numbers, historical events, magazine article titles, unfamiliar foreign language words, and nonsense syllables) and, the reapplication of the same cue-word code to new material without interference from material previously associated with such cues. Such claims obviously run counter to the results of many experiments carried out in our verbal learning laboratories (cf. Jung, 1968). However, before considering the reliable evidence (i.e., other than anecdotal) relevant to the mnemonists' claims, the recent research and theory pertaining to the nature and function of images in associative learning will be

considered. The image, by definition, is an essential element of most mnemonic techniques.

Imagery in Verbal Learning

For purposes of this paper, imagery is regarded as an associative mediator (see below) rather than as a memory trace resulting from the perception of an object. This latter notion, which appears to have originated with Plato's wax-tablet theory of memory (cf. Gomulicki, 1953), is primarily restricted to sensory or iconic memory (Neisser, 1967) and is beyond the scope of the issues considered here.

Historically, the acceptance of the concept of imagery as an explanation for memory phenomena, considered independently of its role in mnemonic techniques, has been varied. The Greeks considered the image to be the basis of all memory (Aristotle, cf. Peters, 1953). During the latter part of the Middle Ages and the early part of the Renaissance both the Church of Rome and various Protestant sects, particularly in England, decried the use of the concepts of imagery as "images" were considered to be "of the devil" (Yates, 1966). Despite this, however, Aristotle's image-based theory of memory did persist in scholarly works, both within the Church and secularly, and the initial investigations into imagery _per se_ were made around the turn of the Twentieth Century (e.g., Galton, 1883; the Wurzburg experiments, 1894-1915, cf. Boring, 1950). The results of such experiments suggested that imagery might not be as central to memory

as had been believed up to that time. Unfortunately, continued research into imagery was largely abandoned about this time with the advent of the new psychology of Behaviorism (Watson, 1913). Watson rejected the concept of imagery as being unacceptably subjective and, as such, not part of a psychology based on overt behavioral data. Because of Watson's influence, particularly in North America, most psychologists of that era and for a long time later rejected any considerations of imagery as being involved in memory and thought processes. The mediating functions in memory and thought, formerly attributed to images, gave way to implicit verbal responses (cf. Goss, 1961). These implicit verbal responses were acceptable to the behaviorist (Deese, 1965) and, as such, resulted in much research in terms of the considerations of meaning and mediation in language as well as in associative learning and memory.

The role of mediation in associative learning has been based on the availability of implicit verbal associates to serve as a "link" in the formation of stimulus word-response word associations (cf. Kjeldergaard, 1968). The availability of these verbal mediation responses is operationally indexed by measures of associability (e.g., Kent and Rosanoff, 1910) or measures of meaningfulness (m) (Noble, 1952) for familiar words and measures of association value for nonsense syllables (e.g., Archer, 1961; Witmer, 1932). Essentially, the greater the availability of implicit verbal associates to the words of an associative learning task,

the more likely that verbal mediation will occur to facilitate the formation of associations (e.g., Jarrett and Scheibe, 1962). Theories of mediation such as Underwood and Schulz's (1960) associative probability theory, Montague, Adams, and Kiess' (1966) natural language mediation, and Glanzer's (1962) "grapnel" theory are all consistent with this view.

Recently, another class of mediation responses have become the subject of a number of investigations pertaining to the processes involved in associative learning and memory. These mediating responses are referred to as images. Osgood (1953) and Mowrer (1960) have persistently argued, despite the emphasis on verbal mediating mechanisms, in favor of the image being a fractional component of the original sensory response to an object. Similar concern with the concept of imagery in associative learning has been evidenced in other recent publications (e.g., Bower, 1967, 1971; Hebb, 1966, 1968; Holt, 1964; Paivio, 1969; Palermo, 1970; Reese, 1965, 1968; Rohwer, 1967, 1970; Staats, 1961). The work of Paivio regarding the functional significance of images as associative mediators is emphasized here, however, because of its extensiveness and because of its apparent relevance to mnemonic techniques <u>per se</u>.

Paivio regards images as "nonverbal memory representations of concrete objects and events, or nonverbal modes of thought (e.g., imagination) in which such representations are actively generated by the individual" (Paivio, in press). The image process may be

directly aroused when a concrete object or event evokes a perceptual trace or it may be associatively aroused when a concrete word evokes an object image (i.e., conditioned sensations). As mentioned above, it is in this latter sense that imagery is considered in this thesis. Theoretically, Paivio (1969) regards the arousal and mediational function of imagery to be linked to an abstract-concrete dimension of stimulus meaning with image arousal becoming more likely as stimulus materials become more concrete (i.e., abstract nouns to concrete nouns to picture to objects).

Operationally, the imagery value of a word (_I_) is obtained by rating scale procedures (Paivio, 1965; Paivio, Yuille and Madigan, 1968) with such values indicating the ease with which a word arouses a mental image or other sensory experience. Another dimension of meaning, concreteness (_C_) (e.g., Spreen and Schulz, 1966) correlates very highly with _I_ (Paivio, Yuille and Madigan, 1968) and, for purposes of this thesis, _I_ and _C_ will be considered to be co-variates. Numerous investigations involving all possible combinations of _I_, _C_, and _m_ on both the stimulus and response members of a paired-associate pair (Paivio, 1967, 1968; Paivio, Smythe and Yuille, 1968; Paivio and Yuille, 1967; Paivio, Yuille and Smythe, 1966; Smythe and Paivio, 1968) have revealed that "imagery-concreteness is the most potent stimulus attribute (in the sense of prediction of learning scores) yet identified among meaningful items, while _m_ and other relevant attributes are relatively ineffective" (Paivio, 1969, p. 241, parenthesis added). That is, in any paired-associate task, associations to concrete word pairs are formed more

easily than associations to abstract word pairs as assessed by immediate recall scores after a single presentation of the material. In addition, the effects of stimulus concreteness have been found to account for eight times the variance relative to the variance attributable to response concreteness (Paivio, 1965).

Subjective report data (e.g., Bugelski, 1968) have also suggested that subjects can and do naturally use imagery in associative learning. A more direct approach to the investigation of imagery mediation, however, is that based upon instructional sets. Again, numerous investigations varying stimulus and response attributes (i.e., I, C, and m) and instructions to mediate either verbally or via imagery have been carried out (Paivio, 1966; Paivio and Foth, 1970; Paivio and Yuille, 1967, 1969; Yuille and Paivio, 1967, 1968) with the following result: "both processes (verbal and imagery mediation) can be effectively manipulated by mediation instructions, but imagery is the preferred mediator when at least one member of the pair is relatively concrete" (Paivio, 1969, p. 241, parenthesis added).

The above represent the major findings regarding imagery as a dimension of meaning and as a mediator in paired-associate learning. Before turning to a consideration of the theory underlying this research, it should be pointed out that these findings do not appear to be restricted to the paired-associate learning task. For example, the imagery variable has been assessed in the context of recognition (Olver, 1965), free recall (Paivio, 1967; Paivio, Yuille and Rogers,

1969), and serial and memory span tasks (e.g., Paivio and Csapo, 1969). The results of these investigations are generally consistent with those obtained in the paired-associate learning experiments. However, these experiments will not be considered here as they are not as directly related to the investigation of the mnemonic technique as are the paired-associate learning investigations. In addition, it should also be pointed out that other investigators have obtained results similar to those of Paivio in the investigation of paired-associate learning. Bower (in press), for example, reports numerous investigations over the past four years which parallel the findings obtained in Paivio's laboratory. Other investigators (e.g., Reese, 1970; Rohwer, 1970) have also engaged in investigations pertaining to the effects of imagery, especially in children's learning, and have obtained results which are consistent with those of Paivio (cf. Reese, 1970).

Two-process Theory of Meaning and Mediation. Paivio's research into the functional significance of imagery processes has resulted in a dual process (i.e., verbal and image process) theory of meaning and mediation for associative learning and memory. The most recent version of the theory is as follows:

> "Concrete terms such as 'house' derive their meaning through association with concrete objects and events as well as through associations with other words, and thereby acquire the capacity to evoke both nonverbal images and verbal processes as associative (meaning) reactions, which could function as alternative coding systems affecting mediation and memory. Abstract terms such as 'truth', on the other hand, derive their meaning largely through intraverbal experiences and more effectively arouse verbal associative than imaginal processes." (Paivio, 1969, p. 248)

This statement of the theory subsumes an earlier hypothesis (Paivio, 1963) which supposedly accounts for the differential effects observed between concrete and abstract words in terms of ease of learning (e.g., Paivio, 1965). The earlier version of the theory (cf. Paivio, 1969) was known as the "conceptual peg hypothesis" and proposed that the subject's representation of the stimulus term of a paired-associate pair functions as a "conceptual peg" to which the associate (response term) is hooked during learning trials and from which the response term can be retrieved on recall trials when the stimulus term is presented alone. It was further assumed that concrete words would function as "better" conceptual pegs than abstract words simply because they more readily arouse images. Unfortunately, Paivio has not, as yet, provided an explanation as to why the conceptual pegs to concrete words (i.e., images) would be "better" than the conceptual pegs aroused by abstract words (i.e., implicit verbal responses).

The above criticism may not be critical to Paivio's theory because of the postulation of the availability of two coding systems (verbal and imaginal) for concrete words and the availability of only one coding system (verbal) for abstract words. To paraphrase an old truism "two codes may be better than one". Bower (1970b), in consideration of the fact that objects are recalled better than pictures, pictures better than concrete words, and concrete words better than abstract words, has suggested that pictures of objects (and presumably concrete words which readily evoke an object image)

should establish both a pictorial engram (memory trace) and a verbal engram. An abstract word establishes only a verbal engram. Such engrams decay over time, becoming less accessible at the time of recall. At recall, concrete words should be better recalled than abstract words because two different engrams exist and "retrieval of either one of them suffices to perform the task" (Bower, 1970, p. 507). Thus, the summative availability of the two codes, rather than a postulation of "better" conceptual pegs, may be a more suitable explanation of the concrete versus abstract differences which have been observed.

In summary, the theory and research pertaining to the effects of imagery in associative learning does indicate that under certain conditions (concreteness value of the materials, instructional sets) imagery can and does serve a mediating function in such learning.

Investigations into Mnemonic Techniques

An important question that remains to be considered is the relationship of Paivio's two-process theory of mediation to the results of investigations into mnemonic techniques. Before turning to this problem, however, it is necessary to define the operations that distinguish the paired-associate learning task from the mnemonic learning task and to review the results of the empirical studies which have dealt with the mnemonic task.

Task Differences. The paired-associate (PA) learning tasks which have been used to investigate the imagery variable have been

of two basic types. The first is the standard PA paradigm in which the concreteness levels of the stimulus and response words have been varied. The instructions to the subjects simply state that they are to learn the pairs of words so that when the stimulus word is presented alone, they will be able to recall the response word. No reference is made to any form of mediation. Sometimes subjects are asked to repeat the pair for as long as the study interval allows (rote-repetition) and sometimes the subjects are left to their own methods of learning (i.e., no instructional set). Usually, each pair is presented for a brief interval (2-4 sec.) on study trials followed by a similar exposure interval for the stimulus word alone on the test trials (e.g., Paivio, 1965).

Of more relevance for comparison purposes with the mnemonic task is the PA task which incorporates instructions to form either verbal or imaginal mediators (hereafter referred to as PAM). That is, on a study trial the subject is instructed to form either a phrase or sentence (verbal mediation) or a mental picture (imagery mediation) which in some way links the two words of the PA pair. On recall trials, the stimulus word is presented alone. Presumably, this leads to the retrieval of the mediator formed on the study trial and ultimately, the response word. The important point is that the stimulus words of the pair are presented on both the study and test trials.

The mediating instructions for the mnemonic task and the PAM task are identical. However, differences do exist between the two tasks.

First, the words which are to function as stimulus words for the mnemonic task are learned prior to the actual learning situation. These stimulus words are initially associated with a series of explicitly presented numbers (e.g., 2-shoe, 8-gate). In addition, the subject is instructed to elaborate upon this cue in terms of forming an image of it. For example, "bun" is to be visualized as a special kind of hamburger bun within which various things might be placed (e.g., an "army" marching around inside the "bun"). For the PAM task, however, the imaginal elaboration of the stimulus word must be made at the time the pair is presented on the study trial. Second, the stimulus word cues are never explicitly presented on the study trial for the mnemonic task. That is, on the study trial only the numbers and the to-be-recalled words are presented - usually in an ascending order (e.g., 1-toy, 2-library, etc.). Upon being presented the number, the subject must himself provide the stimulus word cue and then use this word cue to form the required mediator linking the word cue and the to-be-recalled word. Finally, only the numbers, in a random order, are presented to the subject on the test trial. Again, the subject, upon being presented the number, must provide for himself the word cue that goes with that number in order to retrieve the mediator formed on the study trial.

Two additional distinctions must be made between the two tasks. First, the use of numbers as the explicit portion of the stimulus terms for the mnemonic task provides ordinal information which may

be utilized on the test trial. That is, the numbers provide information as to when a specific to-be-recalled word was presented on the study trial and its temporal relationship with other words in the list. The PAM task subject, however, does not have this type of information available on the test trial. Second, in applying the mnemonic task to successive lists of words, the same set of implicit cue words is used for each list. Otherwise, the mnemonic technique would not be economical. For the PAM task, however, a different set of stimulus words is used for each list (e.g., Wood, 1967) unless, of course, the effects of interlist similarity in the PAM task are being investigated.

In summary, the mnemonic task differs from the PAM task in that order information is available to the mnemonic task subject because of the explicit presentation of the numbers which "prime" the appropriate stimulus word cue. The stimulus word cue must be implicitly supplied by the subject on both the study and test trials. In addition, the mnemonic task subject is instructed to use the same basic image (i.e., his imaginal elaboration of the stimulus word cue) to form mediators with the to-be-recalled words when learning a number of different lists.

Mnemonic Studies. Smith and Noble (1965) investigated Furst's (1957) mnemonic "hook" technique on 10-item CVC lists which varied in meaningfulness (*m*', Noble, 1961). All subjects were initially tested on a spelling speed test and a reasoning abilities test followed by a serial verbal learning practice task. The scores

of these tests served as a basis for forming six matched groups (three experimental and three control groups). Four days prior to the learning phase of the experiment, Ss in the experimental groups were given a one-hour training session on Furst's technique and instructed to practise the technique for at least 15 min. per day. All Ss were then given 20 serial anticipation trials on one of three (low-, medium-, and high-m') CVC lists. Presentation time was 4-sec. per item. The learning scores for each S were the number of correct anticipations on each of the 20 serial anticipation trials. Twenty-four hours later, each S was given 10 relearning trials on the same list of CVCs that had been learned during the learning phase. Recall (loss) over the 24-hrs. was assessed by analyzing the number of correct anticipations on the last learning trial and the number of correct anticipations on the first relearning trial. Relearning scores for each S were the number of correct anticipations on each of the 10 relearning trials. No significant differences between the mnemonic and control groups for each level of m' were obtained for the learning phase. With the exception of the high m' condition, however, learning differences were in favor of better recall for the mnemonic groups. For the recall (loss over 24-hrs.) and the relearning phases of the experiment no differences were found between the mnemonic and control groups for high m' CVCs, large differences were found in favor of the mnemonic group with medium m' CVCs, and small differences were found in favor of the mnemonic group with low m' CVCs. In general, Furst's

mnemonic technique did have a facilitating effect on retention (24-hr. recall and relearning) of low and medium _m'_ CVCs but did not have such an effect during learning. This latter finding is contrary to any claims for the "efficiency" of learning using a mnemonic technique as well as to the investigations which deal with familiar words (see below). Although the formation of mediating images is undoubtedly more difficult with low _m'_ CVCs than for familiar words (cf. Paivio and Madigan, 1968), the failure to find mnemonic versus control group differences with the high _m'_ CVCs (e.g., sun, man, cow) is puzzling. This might be due to the fact that the 4-sec. presentation rate employed was not sufficient for adequate mnemonic "processing" although other investigations (see below) have found this rate suitable for producing significant mnemonic versus control group differences. Senter and Hauser (1968), however, did find Furst's mnemonic technique to be superior to a control condition on a serial anticipation task which consisted of CVCs of equal association value.

Bugelski, Kidd, and Segmen (1968) investigated the rhyme mnemonic technique on a 10-item word list presented at three different rates: 2-, 4-, and 8-seconds. They found that the rhyme mnemonic technique facilitated recall relative to a prior control list (i.e., a 10-item list presented to the mnemonic groups before the mnemonic training) and to a specific control group at the 4- and 8-sec. rates but not at the 2-sec. rate. Hence, mnemonic processing appears to take somewhat more time than is usually made available in

the standard PA situation (usually a 2-sec. presentation rate). An extension of this investigation (Bugelski, 1968) to the learning of six successive 10-item lists revealed that the mnemonic Ss learned the lists better and also evidenced better recall on a final recall test than did the control Ss. In terms of learning the six lists, the mnemonic Ss showed no evidence of negative transfer as a result of using the same implicit stimulus word cues (i.e., the rhyme words) for each list. That is, their level of recall performance on List 6 was approximately the same as for the preceding 5 lists. However, the control Ss (number stimuli but no rhyme words or mnemonic training) did evidence a practice effect. Hence, as Bugelski suggests, the failure to find negative transfer across the six lists for the mnemonic group may have been due to the fact that practice effects masked any negative transfer effects that may have occurred. The final recall test, administered immediately following the study and test trials on the six lists, indicated that the total number of words recalled for the mnemonic condition was greater than the total number of words recalled for the control condition. The interpretation of this finding, of course, is necessarily qualified because of the degree of learning differences for the two groups. In terms of the final recall test, List 2 was the only list which was significantly inferior to List 6 (in terms of recall scores) for the mnemonic group. The control group, on the other hand, evidenced poor recall of the first 5 lists with all such lists being inferior (in terms of recall scores) to List 6. Although Bugelski does not

specify the type of interference operating in the final recall task, it does seem clear that the mnemonic group showed far less evidence of retroactive interference effects than did the control group. These findings do offer tentative support for certain of the claims made by the proponents of commercial memory courses: namely, superior recall after only one presentation of the material and relative freedom from interference effects.

Keppel and Zavortink (1969) replicated the Bugelski (1968) study on four 10-item concrete lists - each list taken to a learning criterion of one perfect trial. Their findings were generally consistent with those of Bugelski, although for groups which received a random order of presentation rather than an ascending order of presentation (as did Bugelski's) of the numbers and to-be-recalled words on the study trials, the effects of retroactive interference were relatively the same for the mnemonic and control groups. While this random presentation of number-word pairs on the study trial is essentially a violation of the mnemonic technique procedure as defined here and in commercial memory courses, Keppel and Zavortink suggest that the finding may indicate that serial order information (based on the numbers) differentially contributes to control group interference effects relative to such effects for a mnemonic group.

Berla, Perensky, and Senter (1969) attempted to determine what differences, if any, in learning time were required for learning via a mnemonic technique as compared with a rote-repetition control group. It will be recalled from the anecdote of Miller, Galanter and Pribram

(1960) that the mnemonic technique should be more efficient, in terms of time to learn a list, than a repetition procedure. Berla et al.'s mnemonic group was trained on Furst's (1957) mnemonic technique and was presented with a 20-item concrete noun list to be learned to a criterion of one perfect trial. The control group received the same list but no mnemonic instruction. Each S could spend as much time as desired on each word on each trial. No differences were found on a trials to criterion measure between the mnemonic and control groups. However, in terms of total learning time, the mnemonic group learned the list in significantly less time than did the control group. Hence, mnemonic techniques appear to be more efficient in terms of learning time than are repetition procedures.

Although employing a procedure which is different from most mnemonic techniques in that the Ss are instructed to successively link each of the words in the list by means of an imaginal mediator (i.e., no word-cue stimulus terms), a series of investigations by Delin (1969a, 1969b, 1969c) do support the results of the above investigations in that the recall of concrete words by a mnemonic group is superior to that of a control group for both "short" (10-item) and "long" (16-item) lists. For both groups, however, the longer list was more difficult to learn than the short list. On a retention test (relearning of the lists six weeks later) the mnemonic group remained superior to the control group although degree of learning differences between the groups might have been responsible

for this finding.

With the exception of the Smith and Noble (1965) study, the results of the above investigations clearly indicate that the mnemonic technique, which incorporates instructions to form imaginal mediators, does facilitate learning relative to control groups which do not have the benefit of mnemonic training. Most of the studies have used only concrete words as the to-be-learned materials. Whether or not a similar difference would occur with abstract words has not yet been determined. Superior long-term retention for words learned via the mnemonic technique also appears to be indicated, although degree of learning differences may be responsible for this effect. Olton (1969), in the context of the PAM task, has investigated the long-term retention of words learned under imaginal instructional sets (degree of learning equated) and did not find such instructions to differentially affect retention relative to a non-mediation control group. Although these retention differences between the PAM and the mnemonic tasks may be due to the fact that degree of learning was not equated in the mnemonic tasks, the differences might also be due to the fact that the two tasks, being operationally different, are also functionally different.

Wood (1967) attempted to determine whether mnemonic instructions did facilitate learning and, if so, what elements (mediational instructional sets, degree of bizarreness of imagery, rehearsal of previously formed images) might be responsible for such an effect. Unfortunately, Wood used the PAM procedure with the stimulus

terms being common nouns (e.g., grape, mustard) rather than any of the commonly used systems of word cues (e.g., bun, shoe, etc.). Wood reasoned that explicitly presenting the word cues (i.e., stimulus terms) would maximize the efficiency of the mnemonic technique. The results of Wood's investigation were generally consistent with those of other PAM investigations (e.g., Paivio and Yuille, 1967). That is, the presence of a concrete stimulus word and instructions to mediate (either verbally or via imagery) did result in superior immediate recall relative to a control group not presented with stimulus words or mediational instructions. Type of mediator (verbal or imaginal), bizarreness of imagery, and rehearsal of previously formed images did not significantly affect performance. The fact that imaginal mediation was not superior to verbal mediation for concrete words is inconsistent with Paivio's two-process theory. Wood also attempted to assess whether negative transfer would affect a mnemonic group using the same stimulus words for each of three lists (A-B, A-D, A-F) relative to a group using different cue words for each of three lists (A-B, C-D, E-F). Negative transfer, in terms of the number of words recalled for each of the three lists, was obtained for the group receiving the same stimulus words for the three lists. Positive transfer was obtained for the group receiving different stimulus words on each list. These findings are consistent with standard PA investigations (e.g., Twedt and Underwood, 1959) but are inconsistent with mnemonic task investigations (e.g., Bugelski, 1968).

Wood's (1967) assumption that the explicit presentation of the word cues would maximize the efficiency of the mnemonic task has been questioned by Paivio (1969). Paivio, using control groups given a mnemonic rhyme but not instructed to use imaginal mediation, assessed the effects of concreteness of the mnemonic rhyme word cues. Four groups and two 10-item concrete word lists were used. All groups were given one study-test trial with the numbers presented in an ascending order on the study trial. Two of the groups then memorized a mnemonic rhyme consisting of concrete word cues (1-bun, 2-shoe, etc.) while two groups memorized a mnemonic rhyme consisting of abstract word cues (1-fun, 2-clue, etc.). Two of these groups (one from each level of rhyme concreteness) were instructed to form imaginal mediators between the word cues and the to-be-recalled words. The two remaining groups were given repetition instructions. Paivio found that the memorization of the rhyme word cues and imagery instructions (List 2) resulted in superior recall relative to first list recall. However, the memorization of the rhyme word cues alone (no mediation instruction) did not. In addition, the concreteness of the rhyme word cues had no effect on the learning of concrete response words for the imagery mediation conditions. This finding is directly opposed to that which has been obtained in the standard paired-associate task in which the concreteness of the stimulus terms has been varied (e.g., Paivio, 1965) and in the PAM task which has varied both word concreteness and mediation instructional sets (e.g., Paivio and Yuille, 1967). Even in

this latter case, item concreteness accounts for more of the variance in recall scores than does instructional sets. That is, in the PA task, stimulus concreteness has been effective with or without the inclusion of imagery instructions. In the mnemonic task, it is not. To account for these findings, Paivio has suggested that in standard PA situations the explicit presentation of the stimulus terms results in a more potent image evoking tendency than do instructional sets whereas in the mnemonic task, the stimulus terms, being implicit, do not function as effective cues for the arousal of mediating images. In other words, imaginal instructional sets are differentially more effective for the mnemonic task in producing learning differences than they are in the PAM task. Conversely, stimulus concreteness is differentially more effective than instructional sets in producing learning differences for the PA and PAM tasks than for the mnemonic task. The implication of this notion is that the PAM task should lead to more efficient learning than the mnemonic task because both stimulus and instruction factors can operate in the former task, whereas only mediation instructions apparently operate in the latter task. In addition, the effects of verbal and imaginal instructional sets should be more clearly delineated in the mnemonic task as the instructional set variable should be relatively unconfounded by the stimulus concreteness variable. These implications regarding possible process differences between the PAM and the mnemonic tasks, plus the fact that the investigations into mnemonic techniques _per se_ have demonstrated little more than mnemonic technique superiority

relative to non-mnemonic groups for concrete materials, serve as the basis for the problems investigated in this thesis.

Statement of the Problem

This study is designed to extend present knowledge regarding the effectiveness and capabilities of three mnemonic techniques which purport to facilitate associative learning and memory. In addition, the study attempts to determine whether imagery mediation is the necessary condition for the effective application of such techniques. These concerns arise from a consideration of the claims made by so-called "memory experts" (professional mnemonists and proponents of commercial memory courses) as well as from a consideration of Paivio's theory and research regarding imagery in PA learning. It should be pointed out that this study is not designed as a "test" of Paivio's two-process theory of meaning and mediation. It is primarily an investigation of mnemonic techniques and attempts to assess the extent to which the results of such investigations are interpretable in terms of Paivio's theory.

Much research has been directed towards a determination of the role of imagery as an associative mediator in PA learning. On the basis of this research, imagery appears to function as an extremely effective mediator facilitating the learning of associations between the stimulus and response words of the PA pairs. The effectiveness of imagery as an associative mediator is determined by the imagery-concreteness value of the PA words, especially the stimulus word, and

may be further enhanced by instructions to utilize imaginal mediators. Despite certain operational differences between the PA tasks designed to assess the effects of imaginal mediation and mnemonic techniques, the two tasks are similar enough to assume that the role of imagery should be the same for the mnemonic task as it is for the PA task: namely, to function as a mediator linking the implicitly supplied stimulus word cues and the to-be-recalled words. By definition, mnemonic techniques are based on instructions to utilize imaginal mediators and, on the basis of the relatively few mnemonic studies available to date, such mediation does appear to facilitate learning in this type of task - at least for words that are relatively concrete. However, it is not known whether imaginal mediation is the necessary condition for mnemonic technique effectiveness nor is it known whether imaginal and verbal mediational processes are differentially effective as a function of the concreteness of the to-be-recalled words in the context of the mnemonic task. To assess these questions, mnemonic techniques which vary according to the type of mediational instructional set which is to be used (verbal or imaginal) are applied to either concrete or abstract word lists. This also allows for a direct assessment of the effectiveness of mnemonic techniques for the learning of abstract words. It will be recalled that one of the claims of the "memory experts" was that the mnemonic technique (and, in this case, mnemonic techniques employing imagery mediation) is effective regardless of the nature of the to-be-recalled words.

In relation to the effects of concreteness and instructional sets in the PA task, this aspect of the study can be conceived of as attempting to determine whether word concreteness and verbal and imaginal instructional sets function in a similar fashion in the mnemonic task as has been found in the PA task.

In an effort to further extend the present knowledge pertaining to mnemonic techniques, two additional claims of the "memory experts" are assessed. First, implicit in the advertising associated with commercially available mnemonic techniques is the claim that the advertised course is superior to any other. As the only major differences among such techniques lie in the nature of the mnemonic word code that each employs, an empirical assessment of these techniques should accomplish two things: an assessment of such claims and, if differences are found, some insight into the functioning of different types of implicit stimulus word codes - a variable which has not yet been investigated in the mnemonic task. To this end, three mnemonic techniques are applied to both concrete and abstract words in this study.

A second claim of the "memory experts" assessed in this study is that, contrary to the findings of many PA investigations, interference effects are not a factor in the application of mnemonic techniques. In an effort to assess this claim and to determine the extent of interference in terms of the loss of particular associations should the claim be specious, five separate lists of to-be-recalled words are included in the experiment (each list to be learned success-

ively with the same set of mnemonic word cues) followed by a final recall test in which recall of all words learned is requested.

CHAPTER 2

Method

Design

Ten groups were used in the experiment. Eight of the 10 groups received instructions in the use of a mnemonic technique to learn lists of words (E groups) and two of the groups, which were tested on the same lists of words, received no such instructions (control groups). The basic design of the experiment was a 5 x 2 factorial arrangement with instructional set defining the 5 levels of the first factor and abstractness of the word lists (nouns) defining the second factor. The five instructional sets were: Rhyme-verbal mediation (RV-), Rhyme-image mediation (RM-), Hook-image mediation (HM-), Stack-image mediation (SM-), and Standard-control (SC-). The two levels of noun abstractness were C (concrete nouns) and A (abstract nouns). The ten groups, therefore, are designated according to instructional set and the abstractness level of the words upon which they were tested: RV-C, RV-A, RM-C, RM-A, HM-C, HM-A, SM-C, SM-A, SC-C, and SC-A.

Because subjects (Ss) were only available for one hour time periods, two experimental sessions were required to carry out the necessary training and testing. The first session (Training session) was held 7 days prior to the second session (Test session) and consisted of a study-test trial on each of two 10-item word lists. Following each test trial a 60-sec. subsequent recall period was given in which subjects could record any responses in addition to the responses

already recorded on the test trial. Mediation instructions, a lecture on mnemonic techniques, and practice with the appropriate mnemonic technique were given to all E groups during the Training session. The control groups received the same series of lists as did the E groups but were given only standard paired-associate learning instructions.

The Test session consisted of one study-test trial on each of five 10-item word lists. The five lists were counterbalanced in presentation by the use of a simple 5 x 5 Latin square to eliminate any possible list difficulty differences. That is, each test list was presented to one-fifth of the Ss in each group as the first test list, to one-fifth of the Ss as the second test list, and so on. Each test trial was followed by a 60-sec. subsequent recall period. Upon the completion of these five immediate and subsequent recall tests, a 10-min. final recall task was given during which as many of the words as possible (maximum 50), studied during the test session, were to be recalled. The final phase of the experiment consisted of a post-experimental questionnaire designed to determine the Ss' ability to follow instructions as well as their prior experience with mnemonic techniques.

Materials

A total of fourteen 10-item lists were constructed and used in the experiment. As the stimulus and response terms were not subject to the same selection procedures each will be considered separately.

Stimulus Terms. The stimulus terms for the first list of the Training session consisted of the numbers 1-10 which were presented in an ascending order on the study trial and in a random order on the test trial. For the second list of the Training session, compound stimulus terms, consisting of a number and an appropriate mnemonic cue word (see below), were presented on both the study trial and test trial. For the five study-test trials of the Test session, only the numbers were presented and the _S_s asked to provide the appropriate mnemonic cue words. Hence, the stimulus terms for the Test session can be considered as the A and B terms of an A-B, B-C, A-C chaining mediation paradigm (Horton and Kjeldergaard, 1960). For simplicity, the A terms (numbers 1, 2, 3, ..., 10) are called the explicit stimulus terms while the B terms (previously learned mnemonic cue words) are called the implicit stimulus terms.

Three different sets of implicit stimulus terms were used. For the groups using the Rhyme-mnemonic technique (RV-C, RV-A, RM-C, and RM-A) these implicit stimulus terms, together with the explicit portion of the stimulus terms, were: 1-bun, 2-shoe, 3-tree, 4-door, 5-hive, 6-sticks, 7-heaven, 8-gate, 9-line, and 10-hen. This abbreviated version of the number-rhyme technique was taken from Miller, Galanter, and Pribram (1960). The implicit stimulus terms for the Hook-mnemonic groups (HM-C and HM-A) were the first ten items of Furst's (1957) number-letter-word mnemonic code. These terms, together with the corresponding numbers, were: 1-tea, 2-Noah, 3-May, 4-ray, 5-law, 6-jaw, 7-key, 8-fee, 9-bay, and 10-toes. The implicit

stimulus terms for the Stack-mnemonic groups (SM-C and SM-A) were selected from Hayes' (1958) list of automobile locations. These terms, together with their corresponding number designates, were: 1-hood, 2-headlights, 3-bumpers, 4-wheels, 5-doors, 6-windows, 7-horn, 8-brake, 9-windshield, and 10-mirror.

Response Terms. The response terms for the 14 lists were 140 nouns selected from the Paivio, Yuille, and Madigan (1968) norms for concreteness (*C*), imagery (*I*), and meaningfulness (*m*) of 925 nouns. The seven 10-item high concreteness (C) lists were randomly selected from a pool of 85 nouns rated high on *C* and *I*. The mean *C*, *I*, and *m* values for these 70 nouns were 6.81, 6.47, and 6.21 respectively. The seven 10-item low concreteness (A) lists were randomly selected from a pool of 85 nouns rated low on *C* and *I*. The mean *C*, *I*, and *m* values for these 70 nouns were 2.41, 3.07, and 5.32 respectively. The variation in *m* for the C and A nouns was impossible to avoid because of the large number of nouns employed in this study and because of the primary restrictions in terms of *C* and *I* values. It was not considered to have seriously affected the abstractness variable as *m* has been found to be largely ineffective in the paired-associate learning of nouns (e.g., Paivio, Smythe, and Yuille, 1968). All of the C and A nouns had a Thorndike-Lorge (1944) frequency count greater than 25 per million. All words, together with their *C*, *I*, and *m* values and grouped according to list, are presented in Appendix A. All study and test trial items were prerecorded using the experimenter's voice.

Post-experimental Questionnaire. The post-experimental questionnaire consisted of nine questions pertaining to the S's understanding of the instructions, clarity of presentation of the word lists, degree of previous familiarity with, and use of, mnemonic techniques, and the S's own evaluation of the experiment. Its primary purpose was to eliminate the data of those Ss having previous training with any mnemonic technique whether or not they reported actively using such a technique in this experiment. A copy of this questionnaire is presented in Appendix B.

Subjects

The Ss were 214 University of Alberta students enrolled in the introductory psychology course who participated in the experiment in partial fulfilment of a course requirement. The data of 14 Ss were discarded: seven Ss failed to return for the Test session, one S failed to learn the mnemonic word code, five Ss reported previous mnemonic training, and the data of one S were rejected because of experimenter (E) error. The Ss were assigned in groups of four to one of the ten conditions in order of appearance at the laboratory. Assignment was made according to a predetermined schedule which randomized, as completely as possible, the ten groups and the five list orders utilized in the Test session. Eight men and twelve women were assigned to each group.

Apparatus

An Ampex AV-770 tape recorder unit, operating at a speed of 3 3/4

ips, was used for the presentation of all study and test trial materials. The 60-sec. subsequent recall periods following each test trial and the 10-min. final recall test were timed with a standard Westclox stop-watch.

Procedure

Upon arrival at the laboratory Ss were met by the E and seated at tables facing a large blackboard which was used for instructional purposes. The E sat at a table to the side of this blackboard and faced the Ss. The tape recorder unit was located upon this table and was operated by the E. Preliminary instructions reminded the Ss that the experiment consisted of two sessions (Ss were informed of this fact when they initially arranged to serve in the experiment) and that the second session (i.e., the Test session) would be held at the same time and at the same place one week hence. The Ss were asked not to reveal the details of the experiment to other members of the introductory psychology class as these persons were also eligible to participate in the experiment. Ss were also informed that a full description of the nature and purpose of the experiment would be given at the end of the second session.

Training Session. Prior to the presentation of List 1, Ss were provided with two response sheets and asked to record their name, student identification number, and List number (given by the E) in the appropriate spaces on one of these sheets. The response sheets contained 10 unnumbered spaces which the Ss were to utilize on the test trial and on

the 60-sec. subsequent recall task. The instructions for List 1 were then read by the E.

The complete instructions for all groups at all stages of the experiment are presented in Appendix C. Consequently, only an abbreviated version of these instructions are presented here. The instructions for List 1 were the same for all groups and essentially asked the Ss to learn which words were associated with which numbers. The number-word pairs were then presented at a 6-sec. rate in an ascending number order. Following the presentation of the tenth number-word pair, the E informed the Ss that the test trial was about to begin. The numbers were then presented in a random order at a 6-sec. rate. The Ss were asked to write down the word that corresponded to the number in a top to bottom order on the answer sheet, marking an "X" in the appropriate space if they failed to recall the word. Following the presentation of the test trial, Ss were instructed that they had an additional one minute to record any words from the list that they now recalled but that they did not record on the test trial. These words were to be recorded on the second response sheet. The Ss were allowed to refer to the test-trial response sheet but were not allowed to make any corrections or additions to it. Upon the completion of this one one-minute period, the E reminded the Ss as to the List number and asked that it be placed on the second response sheet. The E then collected both response sheets and gave each S two more response sheets for use on the second list.

The instructions given prior to List 2 of the Training session

differed for the control and the E groups. Instructions for the control groups (SC-C and SC-A) remained the same as for List 1. For the E groups, however, Ss were instructed that, in addition to the numbers, they would receive a word which was to be used in forming a word, phrase, or sentence which somehow linked it to the to-be-remembered word (Groups RV-C and RV-A) or in forming a mental picture linking it with the to-be-remembered word (Groups RM-C, RM-A, HM-C, HM-A, SM-C, and SM-A). Two condition-appropriate examples were given by the E. The number-word cues, together with the appropriate test words, were then presented at a 6-sec. rate on both the study and test trials. This was followed by the 60-sec. subsequent recall period. These response sheets were then collected by the E.

With the exception of Groups SC-C and SC-A, all Ss were then given a 10-minute lecture on the history and usefulness of mnemonic techniques as an aid to memory. This general lecture did not include references to imagery or verbal mediation but did include some exemplary feats of professional mnemonists as well as a personal anecdote of the E's. Following this general lecture each E group was given an additional 10-minute lecture appropriate to the mnemonic word code and mediational set they were to utilize. The relevant cue words were listed together with their corresponding numbers on the blackboard. The Ss were instructed to memorize this list and, when they thought they had it memorized, to write it down in ascending order on the first response sheet of a 5-page response booklet which they were given. After all Ss had done this the E "spot-questioned" members of each

group by giving a number and asking for the associated cue word or vice versa. Following this, a series of 4 test trials on the word cues was administered. Each test trial consisted of a different random order of the numbers 1-10 presented at a 4-sec. rate. The Ss were asked to write down the cue word that corresponded to each number as these numbers were presented. The remaining 4 pages of the response booklet were used for this purpose. Following each test trial, the E read the correct number-cue word pairs. These booklets were then collected, all instructional material erased from the blackboard, and Ss presented with one more response sheet. The numbers and List 2 words were then presented at a 6-sec. rate for practice purposes. The cue words were not presented on this or any subsequent study and test trials. The Ss were instructed to use the mnemonic technique they had just learned in associating the numbers and words. A test trial followed with only the numbers being presented and Ss asked to record their responses following the same procedures as before. As this study-test trial was for practice purposes only, the results of this test were not considered as part of the experimental data.

The Ss in the control groups also received a re-test on List 2. Prior to this test these Ss engaged in casual conversation with the E for a period of 10-min. on topics unrelated to the experiment. While this did not precisely equate the time interval between List 2 and the re-test on List 2 for the E groups and control groups, this was not considered to be a problem as the data from the re-test of List 2 were

not of experimental interest and were used only to equate the number of lists presented to each group.

Total Training session time for the E groups was approximately 50-min. and approximately 40-min. for the control groups. Because of the difficulty in controlling rehearsal effects, the E groups were not asked to rehearse the mnemonic technique during the one-week interval between the two sessions. In addition, the Ss were not informed as to what the second session would consist of. It would seem reasonable to suggest, however, that at least some of the Ss may have correctly anticipated that the Test session would consist of the application of the mnemonic technique to other lists of words and, as a result, may have engaged in some sporadic rehearsal of the technique.

Test Session. Prior to the presentation of List 1 of the Test session, the E group Ss were reminded of the mnemonic technique they had learned during the Training session. They were then tested on the mnemonic word codes by recalling and recording the appropriate cue words on a response sheet as a random order of the numbers 1-10 was presented via the tape recorder at a 4-sec. rate. These sheets were then collected and each S given two response sheets for List 1 of the Test session. The Ss were instructed to use the mnemonic technique they had studied to learn which words were associated with which numbers. The Ss in the control groups were given a repeat of the instructions used on List 1 of the Training session. No further instructions were given to any group as the study and test trials on each of the five Test session lists proceeded. The presentation

of the study trials, test trials, and 60-sec. subsequent recall tests followed the same procedures as for List 1 of the Training session. The Ss were not informed as to the number of lists they would be presented during the Test session.

Following the presentation (study and test) of the five Test session lists, Ss were presented with a response sheet containing a 10 x 5 matrix. The Ss were asked to recall as many words as possible from the five Test session lists and, wherever possible, to place them in the correct list (columns) and with the appropriate stimulus numbers (rows). The mnemonic word codes were not presented for the E groups. The Ss were also instructed to guess if they were not sure where a recalled word was "located", but to do this only after they had correctly "located" as many words as they were able. Ten minutes was allowed for this final recall test.

Upon completion of the final recall test, Ss were asked to complete the post-experimental questionnaire. Following this, all Ss were given a brief description of the purpose of the experiment. The Ss in the control groups also received a condensed version of the Rhyme-image mnemonic lecture and an example of its use in learning a grocery list. As this experiment was relatively popular with the Ss, they were again asked not to reveal the details of the experiment to other members of the introductory psychology class.

Total Test session time was approximately 45 min. for the E groups and approximately 55 min. for the control groups.

CHAPTER 3

Results

In addition to the graphic representations of the data (Figures 1-5) which are presented within this chapter, the actual mean scores for the data points of these figures are presented in tabular form in Appendix D. Reference to such tables is made in the text by a notation involving the appendix letter followed by an Arabic numeral (i.e., D-1 refers to Table 1 of Appendix D). This notation is used to avoid confusion with the identification of tables which are presented within the text of the chapter (Arabic numerals only) as well as with the tables which are presented in Appendix E (see below).

Specific between-group comparisons at various stages of the experiment were statistically assessed by means of a Duncan's (1955) New Multiple Range Test (DMRT). The summaries of the results of these tests are presented in Appendix E and are designated in the text by the appendix letter and an Arabic numeral (i.e., E-1 refers to the summary of the results of a DMRT presented in Table 1 of Appendix E). In terms of interpreting these tables, any two means which are underscored by the same line are _not_ significantly different at the .01 level of probability. Because of the relatively large number of comparisons possible between the ten groups (45) only those comparisons directly related to the hypotheses underlying this experiment were considered. These comparisons, 16 in all, were of three types: each E group compared with its appropriate control group (RV-C, RM-C, HM-C, SM-C

versus SC-C and RV-A, RM-A, HM-A, SM-A versus SC-A); verbal mediation compared with imagery mediation (RV-C versus RM-C and RV-A versus RM-A); and, comparisons between the three mnemonic imagery groups (RM-C versus HM-C versus SM-C and RM-A versus HM-A versus SM-A). Because of the increased probability of Type I errors with this many comparisons (Edwards, 1960), only differences at the .01 level of probability were considered to be significant.

Immediate Recall Tests

Two scoring criteria were adopted for the immediate recall tests of the Training and Test sessions. The stringent recall (STR) scoring criterion counted as correct only those responses which were appropriately paired with the stimulus terms as presented on each test trial. By the liberal recall (LBR) scoring criterion responses were counted as correct even if they were not appropriately paired with the test trial stimulus terms. In addition, any correct responses that were given during the 60-sec. subsequent recall period following each test trial were included in the LBR score providing that they had not been given on the test trial. The LBR scoring criterion, then, is considered to be relatively free of the order and time constraints inherent in the STR scoring criterion. Neither criterion rejected responses as being incorrect on the basis of spelling errors or errors of number (singular versus plural).

Training Session. The mean STR and LBR scores for each group on Lists 1 and 2 of the Training session are presented in Table 1. On

TABLE 1

MEAN STR AND LBR SCORES FOR EACH GROUP ON
LISTS 1 AND 2 OF THE TRAINING SESSION

List Number	Scoring Criterion	Level of Abstractness	Groups				
			SC	RV	RM	HM	SM
1	STR	C	6.30	5.45	6.15	6.00	6.00
		A	3.95	3.55	3.20	2.90	4.00
	LBR	C	7.55	7.10	7.70	7.45	7.20
		A	5.00	5.60	4.40	5.10	5.05
2	STR	C	4.95	8.75	9.35	8.95	8.30
		A	3.40	5.15	5.50	5.75	6.75
	LBR	C	6.80	8.95	9.20	9.25	9.05
		A	4.70	5.80	5.90	6.20	7.20

List 1 the recall of C words was greater than the recall of A words for both scoring criteria. In order to determine whether these differences were significant, separate Abstractness x Conditions factorial analyses of variance were carried out on the STR and LBR List 1 scores. The introduction of the Conditions factor in these analyses, even though the five groups within each level of Abstractness were as yet undifferentiated by instructional set, provided a method of assessing the homogeneity of the groups employed in this experiment. The results of these analyses, which are summarized in Table 2, were similar. The main effect of Abstractness was significant with more C words being recalled than A words. Neither the main effect of Conditions nor the Abstractness x Conditions interaction was significant.

The finding that C words were better recalled than A words is not new. Numerous paired-associate learning studies in which the stimulus terms are either C or A words (e.g., Paivio, 1965) have demonstrated this relationship for response words which vary on the abstractness dimension. What the finding does indicate, however, is the effectiveness of the Abstractness variable in producing associative learning differences even when the stimulus terms are numbers rather than words. The lack of a significant effect with the pseudo-classification on the Conditions variable indicated that the sampling procedures employed resulted in relatively homogeneous groups within each level of Abstractness.

TABLE 2

SUMMARY OF ABSTRACTNESS x CONDITIONS ANALYSES OF VARIANCE OF STR AND LBR SCORES FOR LIST 1 OF THE TRAINING SESSION

Source	df	MS	F
<u>STR Scores</u>			
Abstractness (A)	1	310.00	80.52*
Conditions (C)	4	3.55	.92
A x C	4	3.38	.88
Residual	190	3.85	
<u>LBR Scores</u>			
A	1	280.84	115.10*
C	4	.61	.25
A x C	4	4.26	1.75
Residual	190	2.44	

* Significant at the .01 level of probability

All groups, with the exception of the control groups (SC-C and SC-A), received condition-appropriate cue words as part of the stimulus terms on both the study trial and test trial of List 2. In addition, these groups (collectively referred to as E groups) received instructional sets to mediate verbally (RV-C and RV-A) or via imagery (RM-C, RM-A, HM-C, HM-A, SM-C, and SM-A) prior to the presentation of List 2. On the basis of Table 1 it is evident that the E groups showed an increase in List 2 recall performance relative to List 1 recall performance for both C and A words by both scoring criteria. Furthermore, List 2 recall performance for the E groups was superior to that of the relevant control groups. The control groups, interestingly, showed a decrease in recall performance on List 2 relative to List 1 recall performance with the decrease being somewhat larger for Group SC-C than for Group SC-A by both scoring criteria.

In order to assess these Training session differences, separate repeated measures Abstractness x Conditions factorial analyses of variance were carried out on the STR and LBR scores. The summaries of the results of these analyses are presented in Tables 3 and 4 respectively. For both scoring criteria all of the main effects were significant: more C words were recalled than A words; instructional sets affected recall performance (see below); and, List 2 recall performance was superior to List 1 recall performance despite the decreased recall performance of the control

TABLE 3

SUMMARY OF ABSTRACTNESS x CONDITIONS ANALYSIS OF VARIANCE OF STR SCORES FOR LISTS 1 AND 2 OF THE TRAINING SESSION

Source	df	MS	F
Abstractness (A)	1	678.61	131.26*
Conditions (C)	4	31.61	6.11*
A x C	4	10.34	2.00
Ss within groups	190	5.17	
Lists (L)	1	374.11	149.05*
L x A	1	2.41	.96
L x C	4	52.74	21.01*
L x A x C	4	5.09	2.03
Residual	190	2.51	

* Significant at the .01 level of probability

TABLE 4

SUMMARY OF ABSTRACTNESS x CONDITIONS ANALYSIS OF VARIANCE OF LBR SCORES FOR LISTS 1 AND 2 OF THE TRAINING SESSION

Source	df	MS	F
Abstractness (A)	1	640.09	192.80*
Conditions (C)	4	15.24	4.59*
A x C	4	4.93	1.48
Ss within groups	190	3.32	
Lists (L)	1	118.81	50.34*
L x A	1	2.56	1.08
L x C	4	18.69	7.92*
L x A x C	4	3.74	1.58
Residual	190	2.36	

* Significant at the .01 level of probability

groups on List 2 relative to their recall performance on List 1.

The decrease in number of words recalled for the control groups on List 2 is somewhat surprising in view of the fact the recall is usually observed to be greater on the second list of a paired-associate task. Such an increment is due, presumably, to the existence of warm-up or learning-to-learn effects (e.g., Thune, 1951). Bugelski, Kidd, and Segmen (1968) have also reported small decrements between the first and second lists for control groups tested on C words under conditions similar to those used here, although they have not commented on these findings. In order to determine whether the decrements in this experiment were significant, separate *a posteriori* *t*-tests were carried out on the STR and LBR scores of Lists 1 and 2 for Groups SC-C and SC-A. The decrement in recall performance was significant for Group SC-C on the STR scores, $t(19) = 2.81$, $p < .05$ (two-tailed test) but was not found to be significant for Group SC-A on the STR scores nor for Groups SC-C and SC-A on the LBR scores with $t(19) = 1.25$, 1.40, and .59 respectively. Although these findings cannot be construed as being particularly definitive, they do suggest that such decrements as have been observed in this and the Bugelski *et al*. investigations might be due to a peculiar consequence of using the same numbers as stimulus terms for the two lists. Presumably, the negative transfer in this situation is more than sufficient to negate any increment in performance attributable to warm-up effects. Because the issue is not of major theoretical

interest to this investigation, the finding and interpretation of the significant decrement in recall performance for Group SC-C (STR scores) will not be further considered.

The Lists x Conditions interaction was significant in both analyses. Quite clearly, the introduction of a stimulus cue word on both the study and test trials plus the instructions to form either verbal or imaginal mediators significantly Improves associative learning relative to the control conditions (i.e., the first list for all groups and the control groups on List 2). None of the interactions involving the Abstractness variable were significant in these analyses.

Separate DMRTs, summarized in Tables E-1 and E-2, were carried out on the STR and LBR scores of List 2 to determine which groups were primarily responsible for the significant Conditions effect obtained in the two analyses. The DMRT (Table E-1) on the List 2 STR scores revealed the following: each E group recalled significantly more words than did the appropriate control group; no differences were obtained between groups instructed to use either verbal or imagery mediation; and, no differences were obtained between the three mnemonic imagery groups. These findings were consistent regardless of whether the response words were C or A. The results of the DMRT (E-2) on the List 2 LBR scores were similar to the DMRT on the STR scores for C words. However, only one of the E groups (Group SM-A) tested on A words recalled significantly more words than did Group SC-A. The direction of the differences for the other E groups

tested on A words was, however, in favor of greater recall for the E groups relative to the control group.

In summary, the results of the Training session analyses indicated that C words are better recalled than A words in the absence of mnemonic cue words and instructions to form either verbal or imaginal associative mediators between the cue words and the to-be-learned words (List 1). In addition, the presentation of the mnemonic cue words with the appropriate number stimuli, together with specific instructions to form mediators, did result in a higher level of recall relative to the appropriate control groups for both C and A words (List 2). These findings regarding explicitly presented cue words and instructional sets are consistent with those of Wood (1967) for somewhat similar conditions. Mediational instructional set, that is, verbal versus imagery, did not differentially affect recall of either C or A words. The absence of any differences between the three imagery groups for both C and A words suggested that the three sets of cue words were equally effective in the formation of mediators.

Test Session. The means for each of the groups on Lists 1, 2, 3, 4, and 5 of the Test session are plotted in terms of STR and LBR scores in Figures 1 and 2 respectively (also presented in Tables D-1 and D-2). For both scoring criteria the groups receiving C words, regardless of instructional set, recalled more words than did the groups receiving A words. In general, the E groups recalled more words than did the appropriate control groups, the differences appearing to be somewhat larger for the STR scoring criterion than for the LBR scoring criterion. In order to determine whether these differences were signi-

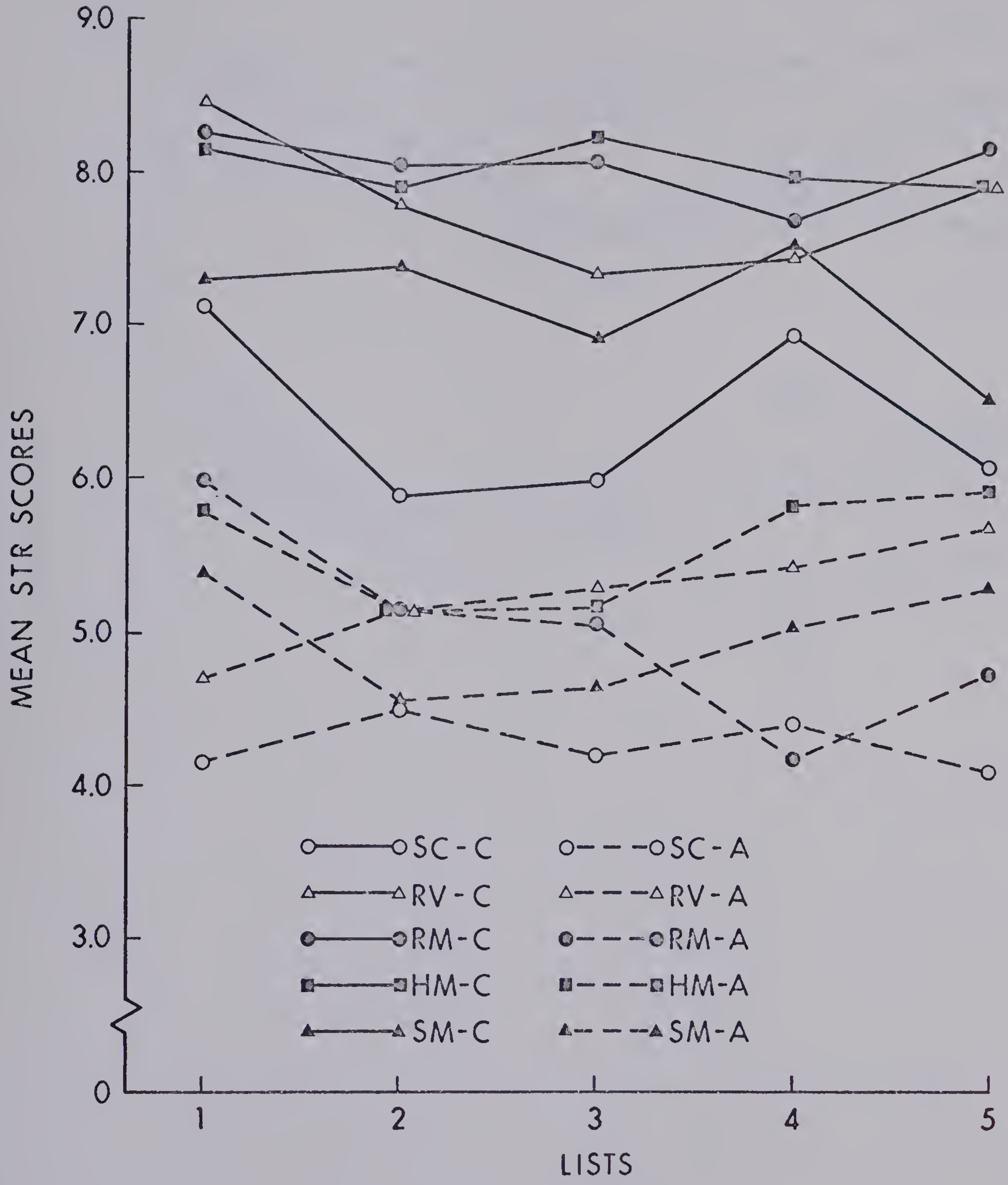

FIGURE 1: Mean stringent recall (STR) scores for each group on the five lists of the Test session.

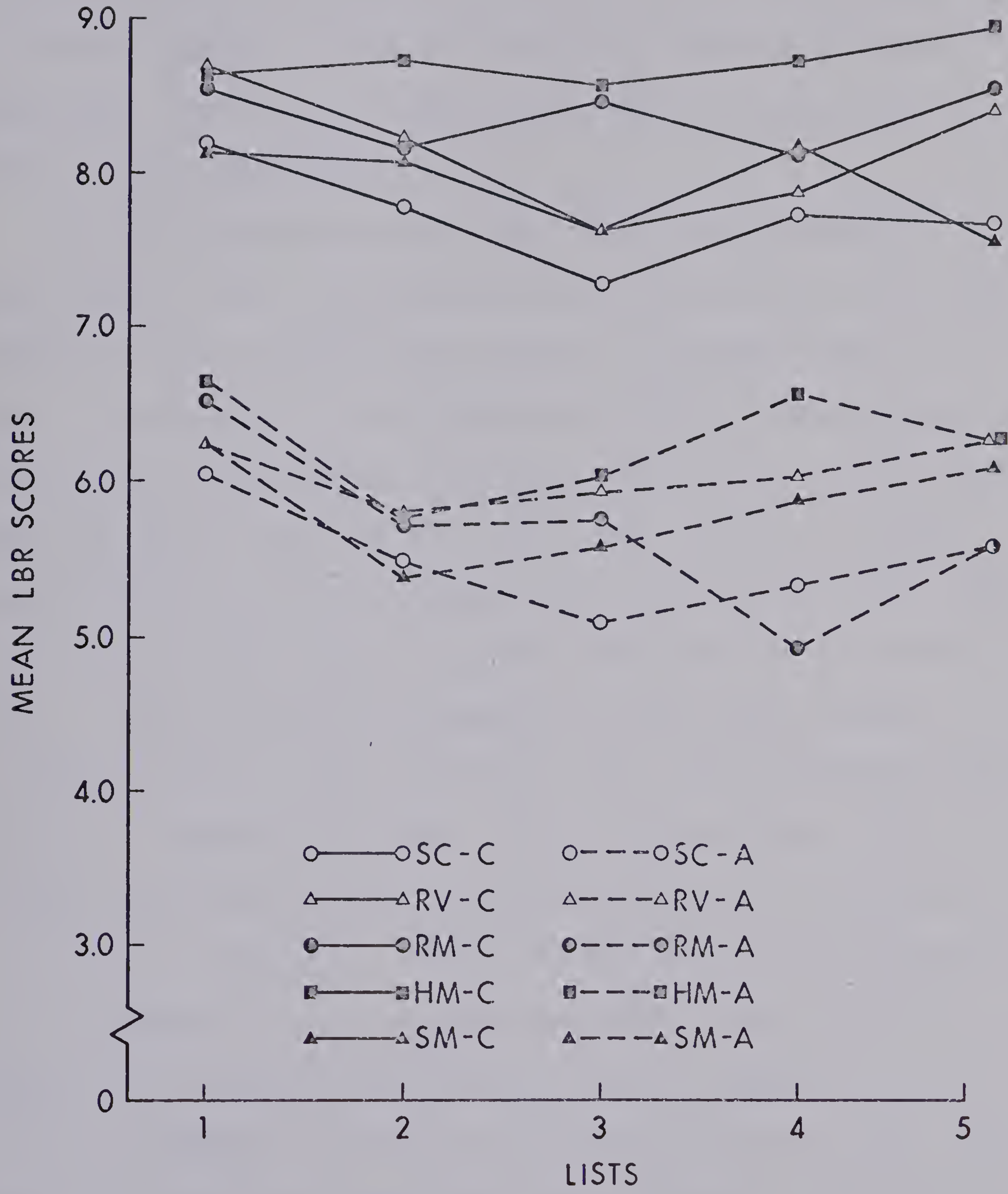

FIGURE 2: Mean liberal recall (LBR) scores for each group on the five lists of the Test session.

ficant, a repeated measures Abstractness x Conditions x Order factorial analysis of variance was carried out on the STR scores of the Test session. A similar analysis was carried out on the LBR scores. The results of these two analyses are summarized in Tables 5 and 6 respectively.

As in the previous analyses, the effect of Abstractness was significant for both the STR and LBR scoring criteria with the groups tested on C words recalling more words than the groups tested on A words. The absence of a significant Order effect in both analyses indicated that the procedure of using each Test session list an equal number of times as the first list, the second list, etc., in each condition had successfully counterbalanced any differences that might have occurred as the result of possible differences in list difficulty. A Lists effect was evidenced in the LBR scores analysis although it only approached significance ($p < .10$) in the STR scores analysis. Inspection of Figures 1 and 2 indicated that recall performance taken over all groups was poorest on Lists 2, 3, and 4 and best on List 1 and List 5. Because the Ss had not been instructed as to the number of lists they would be tested on during the Test session, it is apparent that recall performance, especially on Lists 2 and 3, is affected by some form of interference but that this interference is in some way reduced rather than increased as the number of Test session lists increases.

The main effect of Conditions was significant in the STR scores analysis but only approached significance ($p < .10$) in the LBR scores

TABLE 5

SUMMARY OF ABSTRACTNESS x CONDITIONS x ORDER ANALYSIS OF VARIANCE OF STR SCORES FOR LISTS 1-5 OF THE TEST SESSION

Source	df	MS	F
Abstractness (A)	1	1522.75	121.33*
Conditions (C)	4	67.47	5.38*
Order (O)	4	4.03	.32
A x C	4	6.33	.50
A x O	4	5.11	.41
C x O	16	12.05	.96
A x C x O	16	12.24	.98
Ss within groups	150	12.55	
Lists (L)	4	5.59	2.34
L x A	4	1.53	.64
L x C	16	2.54	1.06
L x O	16	3.60	1.51
L x A x C	16	3.97	1.66**
L x A x O	16	3.51	1.47
L x C x O	64	2.55	1.07
L x A x C x O	64	1.96	.82
Residual	600	2.39	

* Significant at the .01 level of probability

** Significant at the .05 level of probability

TABLE 6

SUMMARY OF ABSTRACTNESS x CONDITIONS x ORDER ANALYSIS OF VARIANCE OF LBR SCORES FOR LISTS 1-5 OF THE TEST SESSION

Source	df	MS	F
Abstractness (A)	1	1336.34	143.69*
Conditions (C)	4	20.67	2.22
Order (O)	4	6.04	.65
A x C	4	3.00	.32
A x O	4	2.39	.26
C x O	16	6.55	.70
A x C x O	16	10.84	1.17
_S_s within groups	150	9.30	
Lists (L)	4	10.57	5.68*
L x A	4	1.71	.92
L x C	16	1.63	.88
L x O	16	2.39	1.28
L x A x C	16	1.50	.81
L x A x O	16	2.11	1.13
L x C x O	64	1.97	1.06
L x A x C x O	64	1.98	1.06
Residual	600	1.86	

* Significant at the .01 level of probability

analysis. In terms of specific between-group comparisons on the STR scores, a DMRT (Table E-3) on the total number of words recalled for each group revealed that no differences existed between the groups instructed to use either verbal or imaginal mediation nor among the groups using the three imagery mnemonic techniques for either C or A words. However, in terms of comparisons between the E groups and their appropriate control groups, Groups RV-C, RM-C and HM-C recalled significantly more words than did Group SC-C. Group SM-C also recalled more words than did Group SC-C although this difference was not significant. For the groups tested on A words, none of the E groups recalled significantly more words than did Group SC-A although the recall performance differences were in favor (i.e., more words recalled) of the E groups. The fact that mnemonic technique superiority, relative to the appropriate control groups, was restricted to groups tested on C words suggested the existence of an Abstractness x Conditions interaction. The significant Lists x Abstractness x Conditions interaction in the STR scores analysis (Table 5) further suggested that the interaction was restricted to only certain of the Test session lists. In an effort to clarify this finding, the mean C and A scores for each condition were plotted separately for each of the five Test session lists and are presented in Figure 3 (Table D-1). Examination of Figure 3 clearly indicates the existence of the Abstractness x Conditions interaction on Lists 2 and 3 and, to some extent, on List 5. The interaction is not readily apparent on Lists 1 and 4. Two factors appear to be responsible for this rather complex state of

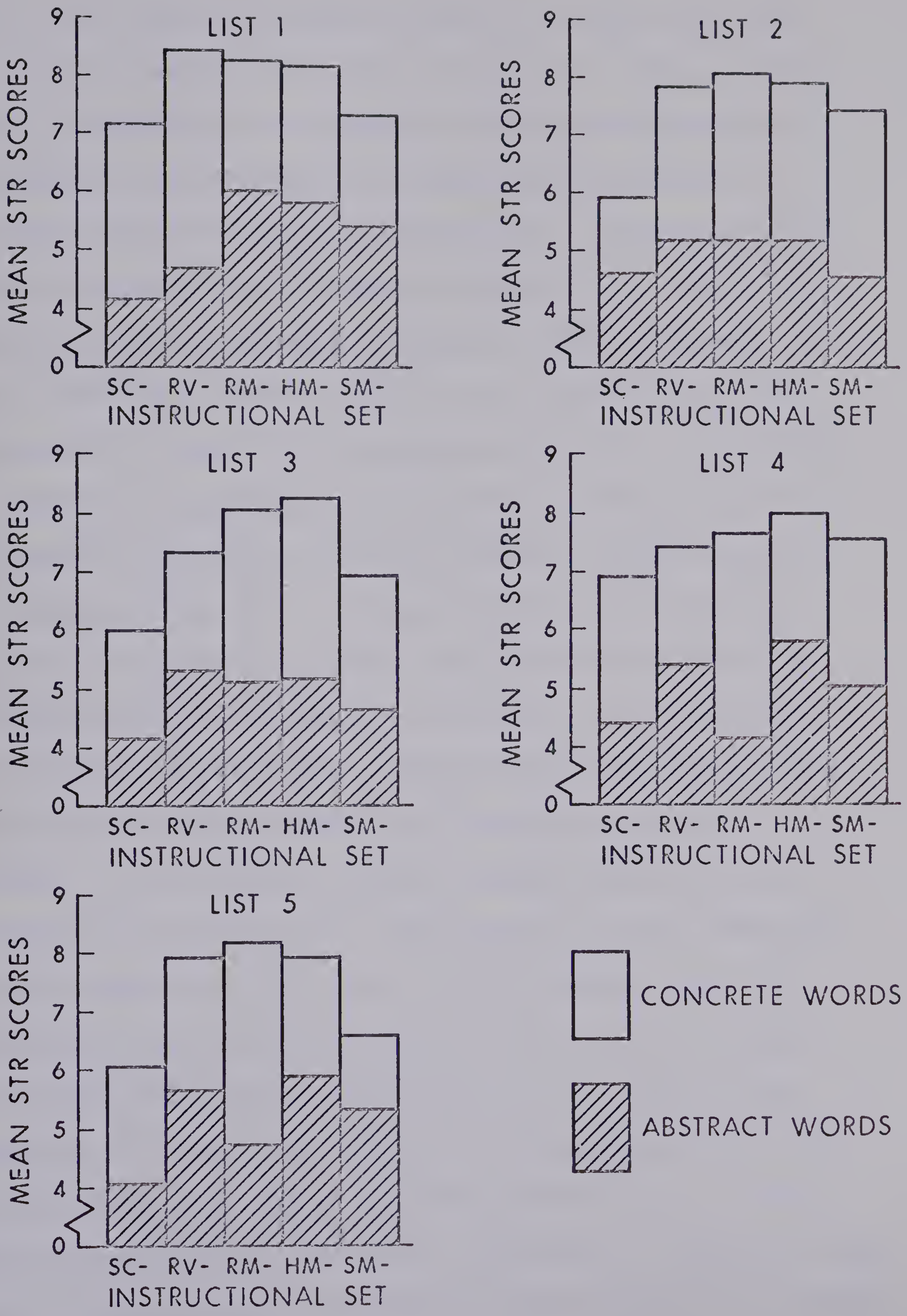

FIGURE 3: Mean stringent recall (STR) scores for each list as a function of instructional set condition (SC- , RV- , RM- , HM- , and SM-) and response concreteness (C and A).

affairs: the recall performance variability of Group SC-C across the five Test session lists; and, an "interaction within an interaction" as evidenced by the increase in recall performance levels for Group RV-A and the decrease in recall performance levels for Group RM-A across the five Test session lists. The variability of a control group tested on C words as a function of the number of successive lists has been noted by Bugelski (1968) in a similar task. According to Bugelski (1968), this variability may be due to the number of associations learned on a given list. For example, if a relatively large number of associations are learned on List 1, these associations interfere with the learning of associations on List 2 and, possibly, List 3. Given that fewer associations are learned on List 3, there are fewer associations to interfere with the learning of List 4 associations, and so on. Quite obviously, this explanation does not apply to Group SC-A of this investigation in which similar recall performance fluctuations might also be expected. In view of this, Bugelski's (1968) explanation is not considered to be a viable one. Unfortunately, no other explanation is readily apparent at this time. A similar problem exists with attempting to account for the recall performance levels of Groups RV-A and RM-A across the five Test session lists. That is, any explanation which may apply to one group does not apply to any other group in which similar effects might be expected to occur. Consequently, no explanation of the Lists x Abstractness x Conditions interaction is advanced here. In the absence of any indication of sampling

problems in this study, it must be concluded that careful experimental attention must be given to the nature of and ease of formation of both types of mediators (verbal and imaginal) as a function of the number of successive lists before the Lists x Abstractness x Conditions interaction found in this study can be clearly understood.

Although the effect of Conditions was not significant in the LBR scores analysis ($p < .10$), a DMRT (Table E-4) was also carried out on the total LBR scores for each group. None of the E groups recalled significantly more words than did the appropriate control groups for either C or A words. Verbal and imagery mediation instructions had no differential effect on the recall of C or A words nor did the use of the different mnemonic cue words for the three imagery mnemonic groups. The comparison of these findings with those of the DMRT on the STR scores suggests the importance of the retention of within-list order information in a demonstration of mnemonic technique superiority over non-mnemonic techniques.

Other than the Lists x Abstractness x Conditions interaction discussed above, no interaction involving any combination of Lists, Abstractness, Conditions, and Order was found in either the STR or LBR scores analysis carried out on the immediate recall scores of the Test session.

In summary, the results of the analyses on the immediate recall

test scores revealed that C words were better recalled than A words regardless of instructional set. This finding is similar to that obtained in the analyses of the Training session scores and indicates again the effectiveness of the abstractness dimension of words in producing associative learning differences. While mnemonically trained groups did recall more words than did groups not so trained, these differences were only found to be significant for three of the four groups tested on C words when within-list order recall was demanded (STR scores). The failure to find similar differences with A words did suggest a Conditions x Abstractness interaction although the finding is of somewhat limited generality due to the fact that the interaction was apparent on only three of the five Test session lists. The reasons for this are not clearly understood at this time. The fact that no E group versus control group differences were found to be significant for either C or A words by the LBR scores analysis suggested that the retention of serial (within-list) order information is an important element contributing to the mnemonic technique superiority observed in this study with the C words. There was no overall advantage or disadvantage in terms of recall for the mnemonic groups instructed to employ imagery mediation relative to those groups instructed to use verbal mediation for either C or A words. Assuming that Ss did adhere to the mediational instructional sets that they were instructed to use, then imagery mediation is a sufficient but not a necessary condition for mnemonic technique superiority - at least when applied to C words. Finally, the absence

of significant differences between the three imagery mnemonic groups on both C and A words indicated that the effectiveness of the mnemonic techniques assessed in this experiment is not differentially affected by the different mnemonic cue words that are utilized.

Errors. The frequency of previous list, intralist, extralist, and omission errors was tabulated for each group on each of the five immediate recall tests. The total number of errors of each type for each group are presented in Table 7. Omission errors accounted for 82.5% of all errors with more than twice as many of these errors attributable to the groups tested on A words. In addition, each E group made fewer omission errors than did its appropriate control group. In view of the fact that an analysis and interpretation of these omission errors would be largely redundant with the analysis and interpretation of the LBR scores presented above, these errors will not be further considered. Intralist errors accounted for 9.6% of all Test session errors, extralist errors for 6.2%, and previous list errors for 1.7%. Because of the relatively small incidence of such errors and because of the resulting skewness of the error distributions (e.g., as few as 3 and as many as 18 subjects made intralist errors in different groups) statistical analyses on these error scores were not considered appropriate.

Examination of the intralist list error scores presented in Table 7 indicated no systematic differences between the groups tested on C words and the corresponding groups tested on A words. Consequently,

TABLE 7

TOTAL PREVIOUS LIST, INTRALIST, EXTRALIST AND OMISSION ERRORS FOR EACH GROUP ON THE IMMEDIATE RECALL TESTS OF THE TEST SESSION

Group	Error Type			
	Previous List	Intralist	Extralist	Omissions
SC-C	4	79	6	269
RV-C	2	12	26	180
RM-C	0	3	17	174
HM-C	2	20	8	164
SM-C	4	43	17	221
Sub-total	12	157	74	1008
SC-A	8	79	17	469
RV-A	19	35	40	380
RM-A	12	25	37	422
HM-A	6	27	26	382
SM-A	7	35	36	423
Sub-total	52	201	156	2076
Total	64	358	230	3084
Percentage of Overall Total	1.7	9.6	6.2	82.5

the frequency of intralist errors does not appear to be a function of the level of Abstractness of the test words. Of primary interest, however, is the fact that each E group made fewer intralist errors than did the appropriate control group. Assuming that this is a reliable finding then further support for the contention regarding the importance of within-list order information for mnemonic technique superiority over the non-mnemonic condition would seem to be indicated.

Most of the extralist errors could be identified as primary associates or generalized forms of the correct responses (e.g., "donkey" for "mule" and "guess" for "chance"). Examination of Table 7 indicated that the groups tested on A words made approximately twice as many extralist errors as did the groups tested on C words. In addition, the E groups tended to make more of this type of error than did the appropriate control groups although, in some cases, the differences were minimal. Although these findings cannot be regarded as definitive, they do suggest that when associative mediators are formed for A word pairs they may be less well formed or of a more general nature than for the C word pairs.

More previous list errors occurred for the groups tested on A words (52) than for the groups tested on C words (12). This finding does suggest that the associative learning of A word lists may be more subject to the effects of proactive interference than is the learning of C word lists.

In summary, the one major finding arising out of a consideration

of the different types of errors that occurred on the immediate recall tests of the Test session was that groups instructed to use a mnemonic technique made fewer intralist errors than did groups not so instructed. This finding adds further support to the contention that at least part of the mnemonic technique superiority observed with the C words on the immediate recall tests STR scores analysis is due to the retention of within-list order information.

<u>Explicit-implicit Stimulus Presentation</u>. Although this experiment was not primarily designed to determine what differences, if any, existed between a list learned with the explicit presentation of the stimulus terms and instructions to mediate and a list learned after mnemonic training (<u>S</u>s must implicitly provide the stimulus terms), a partial assessment of this question could be made. Consequently, a repeated measures Abstractness x Conditions factorial analysis of variance was carried out on the STR scores from two lists (List 2 of the Training session and List 1 of the Test session) for the six imagery-mediation mnemonic groups (RM-C, RM-A, HM-C, HM-A, SM-C, and SM-A). List 1, rather than List 2, of the Test session was selected for comparison purposes for the following reasons: it was not known what effects mnemonic training might have in terms of interference for the second list (List 2) of the Test session and warm-up effects did not appear to be a major factor. The latter reason is based on the assumption that the recall test of the cue words prior to List 1 of the Test session provided warm-up effects similar to the warm-up effects obtained by the groups on List 1 of the Training session.

Furthermore, none of the mnemonic imagery groups, as well as the control groups, showed any evidence of warm-up effects, in terms of the number of words recalled, across the five immediate recall tests of the Test session (see Figure 1). The possibility that differences between the two tests might be due to the fact that the groups mnemonically trained may have suffered from inaccurate recall of the cue word stimulus terms would seem to be obviated by the fact that all but one S (whose data were eliminated) achieved perfect recall of these terms on the test of these terms prior to the presentation of List 1 of the Test session.

The summary of the results of the analysis of the STR scores on the two lists for the six imagery mediation mnemonic groups is presented in Table 8. The usual significant effect of Abstractness was obtained with more C words than A words being recalled. Neither the main effect of Conditions nor the Abstractness x Conditions interaction was significant. The effect of Lists was significant with overall recall performance on List 1 of the Test session being inferior to overall recall performance on List 2 of the Training session. This finding indicated that the explicit presentation of the mnemonic cue words on both the study and test trial facilitated recall performance relative to the mnemonic conditions proper in which the S must implicitly provide the previously learned cue words on the study and test trial. None of the interactions involving Lists, Abstractness, and Conditions was significant.

TABLE 8

SUMMARY OF ABSTRACTNESS x CONDITIONS ANALYSIS OF VARIANCE CARRIED OUT ON LIST 2 TRAINING SESSION AND LIST 1 TEST SESSION STR SCORES FOR THE SIX IMAGERY-BASED MNEMONIC GROUPS

Source	df	MS	F
Abstractness (A)	1	382.54	71.24*
Conditions (C)	2	2.41	.45
A x C	2	9.91	1.84
Ss within groups	114	5.37	
Lists (L)	1	22.20	10.57*
L x A	1	7.01	3.34
L x C	2	4.83	2.30
L x A x C	2	4.81	2.29
Residual	114	2.10	

* Significant at the .01 level of probability

Final Recall Test

The Final Recall Test was added to the Test session in an effort to determine how well Ss retained associations learned early in the Test session relative to those learned later in the Test session. It will be recalled that the mnemonists claim that associations learned via the principles of a mnemonic technique should not be forgotten over time nor lost (interfered with) as a function of subsequent applications of the technique. Of secondary interest was the question of the retention of associations as a function of the level of abstractness of the test words. This Final Recall Test should not be interpreted as being a "precise" test of long-term retention as the length of time between the learning of an association during the Test session and its recall on the Final Recall Test could vary from approximately 5-15 min. (List 5) to 22-32 min. (List 1). The test does assess retention at intervals longer than "immediate" where "immediate" is interpreted to mean a zero time delay between the study and recall trial.

Following the presentation of the five immediate recall tests on Lists 1-5 of the Test session, Ss were presented with a response sheet containing a 5 x 10 matrix. The Ss were asked to recall as many of the words as possible from the Test session lists. The instructions emphasized that words were to be placed in the correct lists (specified by the column headings on the matrix) and paired with the appropriate stimulus number (listed in ascending order in each column). The mnemonic cue words were not listed on the recall matrix. Ten

minutes were allowed for this task.

Observations by the E revealed that 188 of the 200 Ss attempted recall of the last list first (List 5 of the Test session). Nine of the remaining 12 Ss (all mnemonically trained) attempted to recall the five words paired with the first cue word, the five words with the second cue word, and so on. The remaining 3 Ss did not adhere to any systematic pattern of recall.

As with the immediate recall tests two scoring criteria were used. The STR scoring criterion counted as correct only those responses which occurred in the appropriate column and which were paired with the appropriate stimulus number on the final recall matrix. The LBR scoring criterion also demanded that responses be placed in the appropriate column but did not demand that the responses be paired with the appropriate stimulus terms. Spelling mistakes and errors of number did not constitute incorrect responses.

In order to determine how much was retained by each S on each list, a proportion-of-items-retained score was determined for each S. That is, the recall score (STR and LBR scores) of each S for each list on the Final Recall Test was divided by the appropriate score from the immediate recall tests of the Test session. These scores are referred to as STR and LBR ratios. It must be emphasized that, although these ratio scores are appropriate as a measure of retention, any differences among the conditions may be confounded by the terminal level of acquisition (degree of learning) of the various groups on the immediate recall tests. That degree of learning is a major variable

affecting retention has been explicitly pointed out by numerous investigators (e.g., Postman and Riley, 1959; Underwood, 1964; Underwood and Keppel, 1962). Underwood (1964) has proposed two methods for assessing the degree of original learning of materials which vary along some dimension (e.g., meaningfulness, abstractness, pronunciability, etc.). These methods have been found to be highly accurate predictors of the expected recall performance on the trial following the last learning trial (Underwood, 1964). Unfortunately, neither of these methods, nor the variations of them, are applicable to this experiment as the estimates of the degree of learning are based upon each S receiving a constant number of trials (more than one) on each list or learning each list to some specified criterion. In view of this, then, interpretations of the results of the following analyses are necessarily qualified by the possible confounding that may have occurred as a function of the degree of learning.

Recall. The mean STR and LBR ratio scores for each group as a function of each successive immediate recall test are presented in Figures 4 and 5 respectively (also represented in Tables D-3 and D-4). In both cases the last list learned (List 5) is the best recalled whereas Lists 1 and 2 are the most poorly recalled for all groups. The STR ratio values greater than 1.0 for Groups SC-C and HM-C (Figure 4) reflect an apparent "reminiscence" effect for a number of Ss on List 5. Ten Ss in Group SC-C and 8 Ss in Group HM-C contributed to this effect as assessed by the STR scoring criterion. The

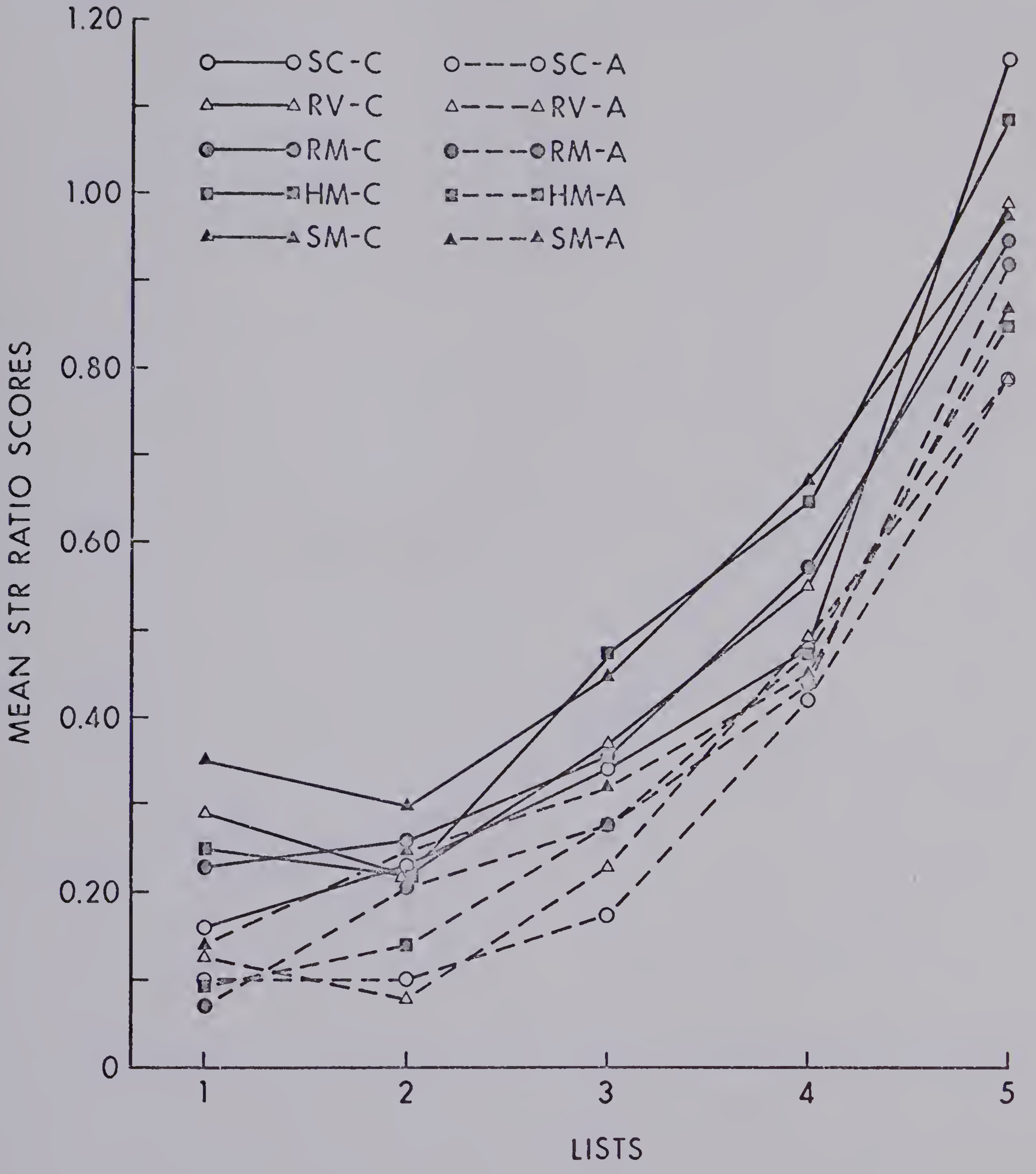

FIGURE 4: Mean stringent recall (STR) ratio scores (final recall/immediate recall) for each group on the Final Recall Test.

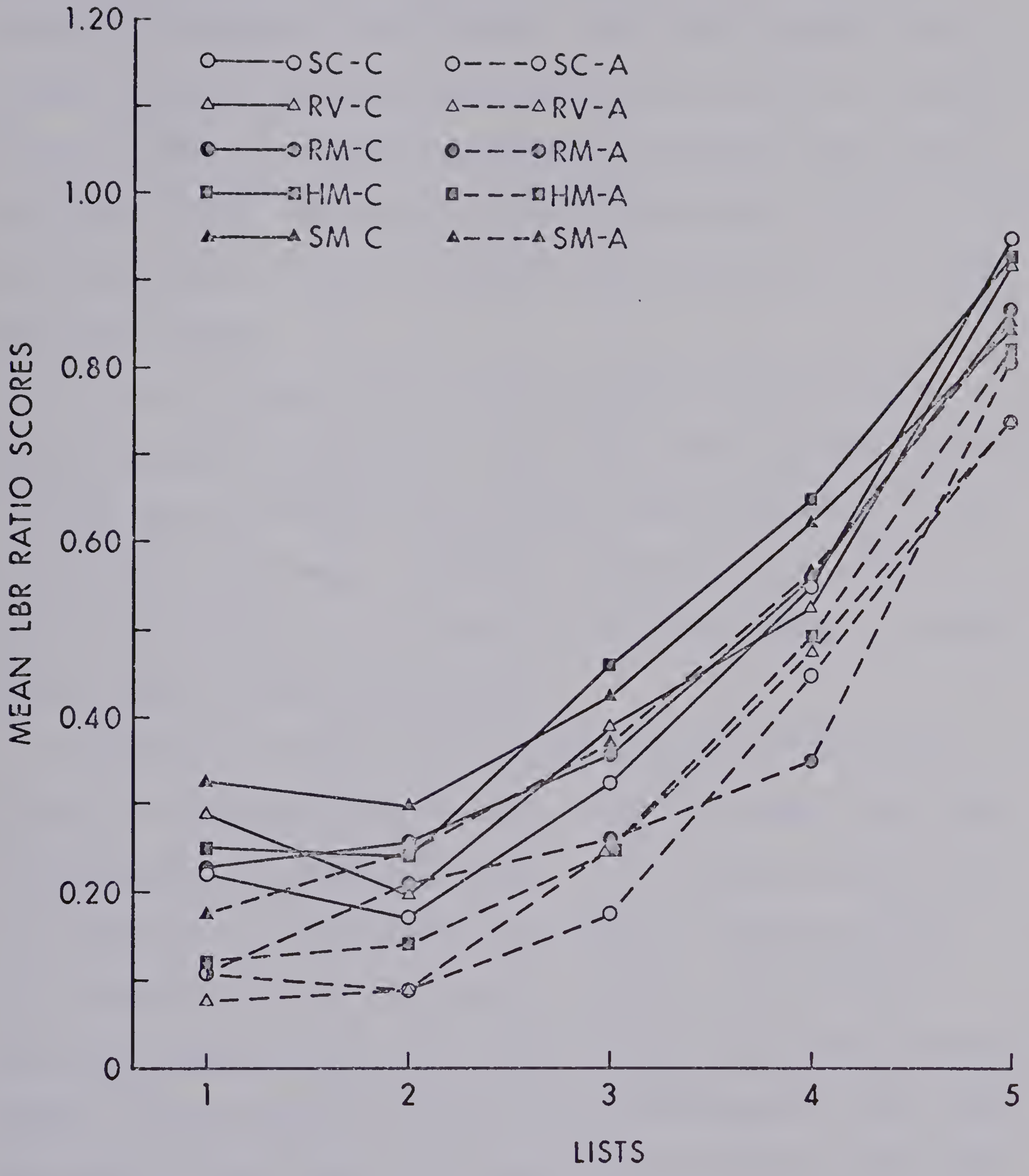

FIGURE 5: Mean liberal recall (LBR) ratio scores (final recall/immediate recall) for each group on the Final Recall Test.

effect, however, was not evidenced in terms of the LBR ratio values (Figure 5) in which only 1 S in Group SC-C and 1 S in Group HM-C showed an indication of reminiscence. Hence, the apparent "reminiscence" effect is considered to be primarily an artifact of the STR scoring criterion. Further consideration of Figures 4 and 5 indicated that C words are generally better recalled than A words although the differences are much less apparent than these found on the immediate recall tests.

In order to assess these and other possible differences, a repeated measures Abstractness x Conditions x Order factorial analysis variance was carried out on the STR ratio scores across the 5 lists of the final recall test. A similar analysis was carried out on the LBR ratio scores. The results of these two analyses are summarized in Tables 9 and 10 respectively.

Groups which learned C words on the five Test session lists evidenced significantly better recall on the Final Recall Test than did the groups which learned A words. If it could be assumed that this finding was not confounded by the degree of learning factor, this finding would be of considerable interest as the effects of noun abstractness on long-term retention have not yet been delineated. However, for the reasons discussed above and because the Final Recall Test cannot be considered as an appropriate test of long-term retention, the finding is regarded as suggestive rather than definitive.

The main effect of Conditions was significant in the LBR ratios analysis but only approached significance in the STR ratios analysis

TABLE 9

SUMMARY OF ABSTRACTNESS x CONDITIONS x ORDER ANALYSIS OF VARIANCE CARRIED OUT ON THE FINAL RECALL TEST STR RATIO SCORES

Source	df	MS	F
Abstractness (A)	1	50594.77	52.17*
Conditions (C)	4	2121.52	2.19
Order (O)	4	2534.57	2.61**
A x C	4	495.25	.51
A x O	4	2034.37	2.10
C x O	16	568.43	.59
A x C x O	16	1313.17	1.36
Ss within groups	150	969.87	
Lists (L)	4	196029.28	334.83*
L x A	4	650.15	1.11
L x C	16	582.73	.99
L x O	16	1165.19	1.99*
L x A x C	16	578.00	.98
L x A x O	16	584.33	1.00
L x C x O	64	802.69	1.37**
L x A x C x O	64	691.70	1.18
Residual	600	585.46	

* Significant at the .01 level of probability

** Significant at the .05 level of probability

TABLE 10

SUMMARY OF ABSTRACTNESS x CONDITIONS x ORDER ANALYSIS OF VARIANCE CARRIED OUT ON THE FINAL RECALL TEST LBR RATIO SCORES

Source	df	MS	F
Abstractness (A)	1	33686.42	53.45*
Conditions (C)	4	3046.68	4.83*
Order (O)	4	1267.20	2.01
A x C	4	497.58	.79
A x O	4	1095.94	1.74
C x O	16	321.20	.51
A x C x O	16	770.44	1.22
Ss within groups	150	630.28	
Lists (L)	4	153361.29	398.56*
L x A	4	318.54	.81
L x C	16	422.56	1.07
L x O	16	816.72	2.07*
L x A x C	16	297.90	.76
L x A x O	16	528.53	1.34
L x C x O	64	618.98	1.57*
L x A x C x O	64	353.01	.90
Residual	600	393.68	

* Significant at the .01 level of probability

($\underline{p}$ < .10). This finding is opposite to that obtained in the analyses of STR and LBR scores of the immediate recall tests. In order to determine which groups were primarily responsible for the significant Conditions effect (LBR ratio analysis), a DMRT (Table E-5) was carried out on the total LBR ratio scores for all groups. None of the E groups which received C words differed significantly from Group SC-C. For the E groups which received A words only Group SM-A recalled more words than did Group SC-A. No differences occurred between the E groups which had studied the lists using verbal mediation and those which had used imagery mediation (RV-C versus RM-C and RV-A versus RM-A). In terms of the comparisons between the imagery mnemonic groups (RM-C versus HM-C versus SM-C and RM-A versus HM-A versus SM-A) only group SM-A recalled more words than did Groups RM-A and HM-A. The DMRT (Table E-6) carried out on the STR ratio scores revealed that none of the groups, in terms of the inner comparisons specified above, differed significantly from one another. Hence, the effect of Conditions on the final recall test is attributable largely to the superior recall of Group SM-A as assessed by the LBR ratio scores analysis. As Group SM-A was not found to be superior in terms of recall performance on the immediate recall tests to any E group tested on A words, it appears that the particular cue words associated with this mnemonic technique might provide retrieval cues capable of integrating more "bits" of information than the mnemonic cue words for the other mnemonic techniques investigated here. However, the absence of recall super-

iority for Group SM-C relative to the other groups receiving C words seriously questions this suggestion. Little more can be said about the Conditions effect in these analyses except that the mnemonic technique superiority which was evidenced for 3 of the 4 mnemonic groups tested on C words relative to the control group on the immediate recall tests (STR analysis) was not evidenced on the Final Recall Test. With the possible exception of Group SM-A, these findings suggested that associations learned via a mnemonic technique are no better recalled on the Final Recall Test than are associations learned in the absence of instruction with such a technique.

The effect of Order (i.e., the five sequences of the five Test session lists) was significant in the STR ratios analysis but not in the LBR ratios analysis. It was further reflected, however, in the Lists x Order and Lists x Conditions x Order interactions for both analyses. This finding with the Order variable was unexpected and is essentially unexplainable. It is not, however, considered to seriously affect the main conclusions deriving from this research as the Order variable was not found to be significant on the immediate recall tests and did not, in any analysis, interact with the Abstractness variable. In addition, it was not of theoretical interest.

As would be expected on the basis of Figures 4 and 5, the effect of Lists was significant in both the STR and LBR ratio analyses. That the terminally presented lists are recalled best and the initially presented lists worst for all groups suggested that associations

learned via a mnemonic technique are lost either as a result of forgetting over time or as a result of some form of interference due to the number of lists. This issue will be dealt with in more detail in the context of a consideration of the errors that occurred on the Final Recall Test.

Other than the interactions involving the Order variable, none of the other interactions involving any combination of Lists, Abstractness, and Conditions was significant.

Although possible confounding exists as a function of differences in degree of learning among the groups, the results of these analyses on the STR and LBR ratios for the Final Recall Test do suggest that: C words are better recalled than A words when retention is assessed at an interval longer than immediate; the effectiveness of mnemonic techniques, as indicated by the greater recall of C words on the immediate recall tests relative to the control groups, appears to be restricted to learning and not to retention; and, associations learned via a mnemonic technique are subject to the effects of interference and forgetting to much the same extent as are associations learned in the absence of mnemonic training.

Errors. The frequency of intralist, interlist, extralist, and omission errors on the Final Recall Test was determined for each S. The total number of errors of each type for each group are presented in Table 11. As was found with the breakdown of errors on the immediate recall tests (Table 7), omission errors were the most frequent comprising 67.0% of the total number of errors made on the Final

TABLE 11

TOTAL INTRALIST, INTERLIST, EXTRALIST, AND OMISSION ERRORS FOR EACH GROUP ON THE FINAL RECALL TEST

Condition	Error Type			
	Intralist	Interlist	Extralist	Omissions
SC-C	43	177	17	452
RV-C	5	250	36	321
RM-C	4	242	19	350
HM-C	8	232	18	314
SM-C	18	213	19	363
Sub-total	78	1114	109	1800
SC-A	41	102	22	691
RV-A	14	171	49	578
RM-A	11	148	63	598
HM-A	14	150	48	564
SM-A	31	135	69	578
Sub-total	111	706	251	3009
Total	189	1820	360	4809
Percentage of Overall Total	2.6	25.4	5.0	67.0

Recall Test. The groups which were tested on A words accounted for almost 63% of these omission errors. Each E group made fewer omission errors than did the appropriate control groups. In view of the fact that an analysis of the omission error scores would be largely redundant with the LBR ratio scores analysis, these errors will not be further considered. Intralist errors accounted for 2.6% of all final recall test errors, extralist errors for 5.0%, and interlist errors for 25.4%. As with the errors of the immediate recall tests, statistical analyses of these error scores were not considered to be appropriate.

In terms of the intralist errors, the distribution of errors among the groups was similar to that of the immediate recall test intralist errors. That is, the control groups tended to make more intralist errors than did the E groups although the frequency of such errors did not appear to be a function of the level of Abstractness of the test words. That these findings are similar to those of the immediate recall tests is not surprising in view of the fact that Ss received no corrective feedback between the end of the immediate recall tests and the final recall test.

The distribution of extralist errors among the groups on the final recall test was also similar to that of the immediate recall test. That is, the E groups tended to make more of this type of error than did the control groups with the largest proportion of these errors being made by the E groups tested on A words. Again, the absence of any sort of feedback between the immediate recall tests

and the Final Recall Test suggested that the findings should be similar on the two tests.

Table 11 indicates that, other than omission errors, interlist errors were the most frequent type of error made on the final recall test. More interlist errors were made by groups tested on C words than on A words. In addition, E groups tended to make somewhat more interlist errors than did the control groups. Although perhaps somewhat elementary, it would seem reasonable to suggest that these differences in interlist error frequency are directly related to the number of associations learned on the immediate recall tests of the Test session. That is, the larger the number of associations learned in each one of a number of lists, the greater the probability that such associations will be "misplaced" in terms of correct list placement of the response words on the Final Recall Test.

It must be emphasized that this experiment was not designed, in terms of specific control groups, to assess the relative contributions of forgetting and interference in accounting for the Lists effect observed in the preceding analyses nor for specifying the amount of specific types of interference (i.e., proactive and retroactive) which might develop as a function of learning a number of lists. The relatively high incidence of interlist errors, however, does suggest that the significant Lists effect, observed in both the STR and LBR ratio scores analyses of the Final Recall Test, is primarily due to interference rather than forgetting *per se*.

CHAPTER 4

Discussion

Conclusions

The major findings of this study were:

(1) Concrete words were significantly better recalled than abstract words for all phases of the experiment. That is, during the Training session, concrete words were better recalled than abstract words both in the absence of stimulus word cues and mediational instructional sets (List 1) and in the presence of such cues and instructional sets (List 2). During the Test session, concrete words were also consistently better recalled than abstract words for all groups which received mnemonic instruction and for the control groups which did not receive such instruction. Finally, concrete words were significantly better recalled than abstract words on the Final Recall Test, although this finding is difficult to interpret because of the differences in the terminal level of acquisition obtained on the immediate recall tests between the groups tested on concrete words and the groups tested on abstract words. All of the above differences were obtained with both the stringent and the liberal scoring criterion suggesting that the recall of concrete and abstract words was not differentially affected by the demand for within-list ordinal information.

(2) For the Test session phase of the experiment, three of the four mnemonic groups evidenced significantly better recall of concrete words than did a non-mnemonic control group also tested on concrete words.

None of the mnemonic techniques was significantly superior to a non-mnemonic control group when tested on abstract words. This interaction of instructional set condition (i.e., mnemonic versus non-mnemonic) with word abstractness appeared, however, to be restricted to three of the five Test session lists for reasons which are not clearly understood. These findings were restricted to the analysis of recall scores based on the stringent scoring criterion and were not obtained when the liberal scoring criterion was used. The differences in the results of these analyses indicated that the serial order information provided by the number stimuli is more effectively utilized for specific item recall in the context of the mnemonic task relative to the situation in which the number stimuli are not linked with a set of word cues (non-mnemonic control groups). Further support for this finding was obtained in terms of the greater frequency of intralist errors for the control groups relative to the mnemonic groups.

(3) Verbal and imaginal mediation instructions, in the context of the mnemonic techniques, did not differentially affect the recall of either concrete or abstract words. Consequently, imagery mediation cannot be considered to be the necessary mediation condition for mnemonic technique effectiveness as has been implicitly assumed by most mnemonists and in the recent investigations into mnemonic techniques <u>per se</u>.

(4) No significant differences existed in terms of immediate recall among the three mnemonic groups employing imagery mediation for either concrete or abstract words. Because of the equivalence of imagery mediation instructions for these techniques, it is concluded that the

mnemonic word codes and, as a result, the three mnemonic techniques themselves, are not differentially effective in producing recall differences.

(5) The mnemonic technique superiority over the non-mnemonic control group evidenced during the acquisition phase of the experiment (i.e., immediate recall tests) for concrete words was not evidenced on the Final Recall Test. This finding indicated that while mnemonic techniques facilitate the rate of original learning, they do not affect retention - at least not for the retention intervals that existed in this study (5-32 minutes depending on which word list the S was attempting to recall). As mentioned previously, however, the retention findings are only suggestive due to the degree of original learning differences between the groups.

(6) Associations learned late in the acquisition phase of the experiment were generally well recalled on the Final Recall Test (liberal recall ratios of .74 - .95 for List 5) but associations learned early (List 1) were poorly recalled (liberal recall ratios of .08 - .33). This significant difference in number of associations lost was consistent for all mnemonic and non-mnemonic groups and suggested that association loss, either as a function of interference and/or forgetting does occur for mnemonic techniques as well as for non-mnemonic learning methods. The relatively high incidence of interlist errors for the mnemonic groups on the Final Recall Test suggested that interference effects were indeed a major variable affecting the observed loss of associations. However, because appropriate control groups were not run, the relative

contributions of proactive and retroactive interference to such association loss could not be determined. Similarly, whatever loss occurred simply as a function of forgetting over time could not be ascertained.

(7) Immediate recall of associations learned with the explicit presentation of the word cue stimulus terms on both the study and test trials (List 2 of the Training session) was significantly better than the immediate recall of associations learned when the Ss using the mnemonic technique had to implicitly provide the word cue stimulus terms (List 1 of the Test session). Assuming that warm-up effects were adequately controlled for and that the 6-second presentation rate was sufficient for mnemonically trained Ss to retrieve the word cue from the number stimulus and to form the required mediator (both assumptions seemingly tenable in the light of the evidence presented here), the finding is of major interest as it indicates that the operational differences between the mnemonic and paired-associate learning tasks do result in learning differences. In effect, the finding indicates that the mnemonic task cannot be analyzed solely in terms of the variables presumed to account for associative learning in the paired-associate task (e.g., word abstractness, instructional sets).

General Discussion

The implications of the above findings are discussed in three separate sections. The first section deals with the results of this

investigation in relation to the claims made for mnemonic techniques in general and in relation to the theoretical considerations pertaining to verbal and imaginal mediation processes in associative learning and memory (cf. Paivio, 1969). The second section deals with what might be considered to be the "fairness" of this and other laboratory investigations in assessing the purported superiority of mnemonic methods over other associative learning methods. The final section is concerned with the nature of the mnemonic word cues and their imaginal representations as "associative hooks" which remain consistent between learning (study trial) and recall (test trial).

Empirical and Theoretical Considerations. The fact that concrete words were consistently better recalled than abstract words for the mnemonic conditions is inconsistent with the advertising claims associated with commercial memory courses and certain mnemonists (cf. Luria, 1968). In addition, the fact that the superiority of the mnemonic techniques relative to a non-mnemonic control was only apparent for concrete words suggested that the utility of such techniques may be restricted to materials which readily arouse imaginal representations (e.g., concrete words, perceived events). These findings are consistent with that portion of Paivio's theory dealing with imagery mediation and word abstractness (Paivio, 1969). That is, imagery mediation should result in superior recall of concrete words as the concrete words themselves readily arouse imaginal representations which may then be integrated with the imaginal representation the S has of the mnemonic word cue. For abstract words, however, the formation of imaginal

mediators linking the implicit mnemonic word cues with to-be-recalled words is much more difficult because the abstract to-be-recalled word does not readily arouse an imaginal representation of it. Hence, the failure to find mnemonic technique superiority relative to a non-mnemonic control with abstract words may be interpreted in terms of the failure to "discover" an imaginal representation of the abstract word.

The finding that imagery mediation was not superior to verbal mediation for concrete words and that verbal mediation was not superior to imaginal mediation for abstract words is inconsistent with that portion of Paivio's theory which may be referred to as the "availability hypothesis". This hypothesis, in the context of paired-associate learning, states that imagery mediation is more effective with concrete word pairs than is verbal mediation simply because of the image arousing capacity of such words. For abstract words, however, verbal mediation is presumed to be more effective because of the availability of verbal associative reactions and the difficulty of discovering appropriate mediating images for such pairs. The hypothesis has been supported in a paired-associate task using concrete and abstract word pairs as a between Ss variable and instructional sets (verbal and imaginal) as a within-Ss variable (Paivio and Foth, 1970, Experiment I). Because the implicit word-cue stimulus terms of the mnemonic task are relatively concrete, no condition comparable with the abstract word pair condition of the above study existed in this investigation. However, if Paivio's suggestion regarding the differential effectiveness of the stimulus

terms and mediation instructions in the paired-associate and mnemonic tasks is correct (i.e., mediation in the mnemonic task is primarily based on mediation instructions as the implicit stimulus terms do not effectively arouse mediating images - Paivio, 1969), then it may be assumed that instructional sets alone should produce the mediation instructional set by word abstractness interaction in the mnemonic task.

The failure to find this instructional set by word abstractness interaction suggests two things. First, the abstractness of the stimulus terms may indeed be a factor in terms of the effectiveness of the mediation instructional sets in the context of the mnemonic task. If this is the case, Paivio's ad hoc explanation of the differential effectiveness of stimulus concreteness and mediation instructions in the two tasks may not be correct. It is critical, both to Paivio's theory if it is to be applied to the mnemonic task and to an understanding of mnemonic techniques per se, to resolve this issue. Alternatively, the failure to find the word abstractness by instructional set interaction may have been due to the fact that the instructional sets employed in this investigation were not as "strong" as those employed in the Paivio and Foth (1970) study. It will be recalled that in that investigation Ss were "forced" to use a particular mediational set by requiring them to draw the mediator (imaginal mediation) or write a phrase or sentence (verbal mediation) linking the two words of each paired-associate pair as

they were presented on the study trial. However, such a "forcing" procedure cannot be considered to be appropriate for an assessment of mnemonic techniques as it violates the very essence of the mnemonic technique.

The finding that recall was significantly higher for the six imagery mediation mnemonic techniques when the mnemonic word cues were explicitly presented than when such cues had to be implicitly provided attests to the fact that the operational differences between the paired-associate and the mnemonic tasks are critical. Operationally, this difference in the nature of the word cues results in an extra "link" in the mediational chain for the mnemonic S. Relative to the paired-associate task this extra "link" consists of recalling the appropriate cue word to the number stimulus on both the study and test trials. Should the S fail to recall the cue word on the study trial a mediator cannot be formed linking it with the response word. Obviously, response recall to the number stimulus cannot effectively occur on the test trial in this situation. If the S recalls the cue word and forms a mediator linking it with the response word on the study trial but does not recall the appropriate cue word on the test trial, response recall again is difficult. In either case the mnemonically trained S is at a disadvantage to the S in the paired-associate situation who has the stimulus words explicitly presented on both study and test trials. The latter S may only fail to form or retrieve the mediator whereas the mnemonically trained S may also fail to retrieve the appropriate

stimulus word cue which is prerequisite for mediator formation and the retrieval of the response. To the extent that the stimulus word cue is not always elicited by the number stimulus (i.e., probability less than 1) this notion is also consistent with the association chaining mediation hypothesis of Jarrett and Scheibe (1962).

In relation to the viability of both verbal and imaginal mediators in the mnemonic task, it must be pointed out that descriptions of contemporary mnemonic techniques simply assume that imagery mediation is the necessary type of mediation for making such techniques "work". However, as indicated in Chapter 1, mnemonic techniques based only on verbal mediation have also existed (e.g., Ramon Lull, cf. p. 11). Independent of the recent theory pertaining to mediation in associative learning, the emphasis on imagery in such techniques has probably been due to historical precedent rather than any serious consideration as to whether or not imagery mediation was indeed the necessary condition. However, the present finding regarding the "equal effectiveness" of the two types of mediation need not be considered troublesome by the "memory experts" as imagery mediation is at least as effective as verbal mediation.

The difference in the Test session results regarding mnemonic technique superiority with concrete words, obtained on the basis of the two scoring criteria (stringent and liberal), did suggest that ordinal information is more effectively utilized by mnemonically trained <u>S</u>s than by <u>S</u>s without benefit of mnemonic training (non-mnemonic control groups). This may be an indirect consequence of the "importance" attached to the numbers for retrieving the implicit stimulus word cues

during the training on the mnemonic code. More likely, however, is that the ordinal information becomes associated with responses (i.e., the implicit stimulus word cues) which are more effective retrieval cues than is the ordinal information itself. It must also be pointed out that the failure to find differences between the mnemonic and non-mnemonic groups by the liberal scoring criterion may be attributable to the shortness of the lists (10 words) used in this investigation. That is, for the non-mnemonic groups response recall alone may have raised recall performance levels to the point that it nullified any differential effects attributable to the mnemonic techniques. Ostensibly, with longer lists mnemonic technique superiority relative to a control group should be evidenced with concrete words even when within-list order recall is not demanded.

The fact that no significant differences in immediate recall were found among the three imagery mediation mnemonic techniques suggested that the nature of the word cue code is relatively unimportant once the particular code is learned. More importantly, perhaps, is that all word cues, regardless of whether they rhyme with numbers, originate with number-letter identities, or are component parts of a larger, familiar "image" (i.e., the automobile), are equally effective in arousing imaginal representations which may be used to form a mediator with the imaginal representation of the to-be-recalled word. This finding is not particularly surprising as the majority of such words are relatively concrete. For those which are not concrete (e.g., heaven, fee), the mnemonic instruction associated with learning the codes (see Appendix C) would appear to make them as capable as the concrete ones in terms of

image arousal.

The finding regarding the negligible amount of interference effects for the mnemonic conditions on the original learning tests is consistent with the findings of Bugelski (1968) and Keppel and Zavortink (1969). In addition, the finding is consistent with the claims made by the "memory experts" for the mnemonic technique (e.g., Roth, 1961). Although such interference may have been masked by a practice effect across the five Test session lists, the fact that the non-mnemonic control groups did not demonstrate such an effect suggests that the finding may be reliable. However, in the absence of information as to how the non-mnemonic control group Ss learned the lists, the finding must be regarded as tentative. Quite obviously, the final assessment of this question must be made in the context of an experimental design which incorporates both mnemonic and non-mnemonic control groups at each list position.

Although the interference effects obtained on the Final Recall Test are necessarily qualified by the lack of appropriate control groups and the terminal level of original learning for the groups assessed in this study, the inability of the mnemonic groups to recall List 1 associations relative to their recall of List 5 associations plus the relatively high frequency of interlist errors that occurred for these groups, suggested that the claims of the "memory experts" regarding correct recall of items learned prior to subsequent applications of the same mnemonic technique may be in error. However, the finding obtained here is also inconsistent with other mnemonic investigations (e.g., Bugelski, 1968; Keppel and Zavortink, 1969). Differences in

procedure between the three experiments may account for the discrepant findings. It will be recalled that in this experiment the Ss were not presented with the word cue stimulus terms on the Final Recall Test and that the majority of the Ss attempted to recall the last list first, followed by the second last list, and so on. Bugelski (1968) asked his Ss to give all of the response words that were associated with the first word cue, all of those with the second, and so on. These words were then tabulated by list by the experimenter thus eliminating one major measure of interference effects, namely, inter-list errors. Keppel and Zavortink (1969) employed a recall matrix similar to the one used in this investigation except that their matrix did include the word cues. This may have differentially facilitated the recall of first and second list associations for their mnemonic groups relative to the mnemonic groups in this investigation.

In summary of the above, the results of this investigation indicated that the mnemonic task is not completely analyzable in terms of Paivio's two-process theory of meaning and mediation as it applies to the paired-associate learning task. The major reasons for this conclusion are: (1) If the two tasks were similarly affected by the same variables, no difference would be expected to occur for the case where the cue words are explicitly presented on study and test trials (paired-associate task) and the mnemonic situation in which the S must implicitly provide such cues. A difference was found, however, such that recall was superior in the former case. Because instructions to mediate were identical in both cases, it is concluded that the difference is due

to the explicit and implicit nature of the stimulus terms in the two tasks. Specifically, the requirement of having to recall and provide the stimulus term for mediator formation and retrieval in the mnemonic task decreases the probability, relative to the paired-associate task, that mediator formation and retrieval will occur.

(2) The interaction between mediation instructions (verbal and imaginal) and abstractness of the to-be-recalled words (concrete and abstract), predicted by the theory and obtained for the paired-associate task (Paivio and Foth, 1970), was not obtained for the mnemonic task. That the interaction should occur was based on the assumption that the instructional sets alone should be sufficient to induce the appropriate mediational strategy within the context of the mnemonic task. While the assumption may be somewhat tenuous, Ss did report, both on the post-experimental questionnaire and in conversation with the experimenter, adherence to the mediational strategy they had been instructed to use. In other words, little, if any, "strategy change" appears to have occurred in this investigation. Such changes have been observed to occur, however, in the context of the paired-associate learning task (Paivio and Yuille, 1969).

The data presented here are not sufficient to precisely specify the nature of the differences between the mnemonic and the paired-associate learning tasks as paired-associate controls receiving the mnemonic word cues as stimulus terms, both with and without the verbal and imaginal mediation instructional sets, were not included in the

Test session phase of the experiment. Hence, a formal model to account for the mnemonic task findings is not advanced here. However, on the basis of the obtained findings, it appears that the operational differences between the two tasks do result in empirical differences and that the two-process theory of meaning and mediation for association learning and memory is not sufficient nor completely appropriate to an analysis of learning following training with a mnemonic technique.

Laboratory Investigations of Mnemonic Techniques. The claims made by mnemonists and proponents of commercial memory courses regarding mnemonic techniques are quite correctly meant to apply only to those individuals who have in some sense "mastered" the technique and continually use it. Obviously, the degree of practice afforded the *Ss* during the Training session of this experiment does not correspond with the degree of practice one would obtain when taking a commercial memory course. However, large amounts of practice, once the word cue code has been learned and the mediation principles understood, may not be necessary. For example, the performance levels of all mnemonic groups receiving concrete words on List 1 of the Test session corresponded to the performance level of Smith and Noble's (1965) high-*m*' CVC group (tested on such words as sun, man, war, etc.) after 10 serial anticipation trials on a 10-item list and after 4 consecutive days of practice (at least 15 minutes per day) with the technique. This practice was in addition to a one hour training session. Furthermore, the fact that performance levels

did not increase for the imagery mediation mnemonic groups or the non-mnemonic control groups in this investigation across the five lists of the Test session (although such an increase may have been masked by an interference effect) also suggests that practice effects may have been largely accounted for during the Training session.

A critical distinction between laboratory investigations of the mnemonic technique and the application of mnemonic techniques outside the laboratory is the time allowed to form associations. When applying a mnemonic technique outside of the laboratory, individuals usually "pace" themselves in terms of taking as much time as is necessary to form the required association. Bugelski (1968) has reported that on a self-paced task Ss employing a mnemonic technique took, on the average, about 8 seconds to form associations for concrete words. Although this investigation used a 6-second presentation rate, recall performance levels for mnemonic groups tested on concrete words were similar to those reported by Bugelski. In addition, Bugelski, Kidd, and Segmen (1968) have found that a 4-second presentation rate was sufficient to demonstrate mnemonic technique effectiveness over a non-mnemonic control group for concrete words. Consequently, the presentation rate used here does seem to be adequate, at least for concrete words. The 6-second rate may not have been sufficient for the abstract words, however, because of the fact that a concrete associate and its imaginal representation must first be found for the abstract word before an appropriate mediator can be formed. This does presume that such

associates can be found for all abstract words although this has yet to be demonstrated. Assuming that such is the case, however, another issue arises. It will be recalled that the mnemonic technique is supposedly "efficient" in terms of "time-to-learn" material one wishes to recall. However, if concrete associates are not readily available for abstract words and a great deal of time must be spent in discovering such associates, the mnemonic technique loses its time advantage and may be no more efficient than the S's own idiosyncratic learning methods or even, say, rote repetition.

For the above reasons, this investigation, as well as the other reported investigations into mnemonic techniques, can be regarded as providing a reasonably accurate assessment of the effectiveness and capabilities of mnemonic techniques.

Prepotency of Mnemonic "Associative Hooks". In recent years attention has been directed towards an understanding of the nature and function of retrieval cues in memory (e.g., Melton, 1963; Mandler, 1967). It has been demonstrated that specific retrieval cues do facilitate recall (e.g., Tulving, 1962; Tulving and Pearlstone, 1966) and that such facilitation occurs when the retrieval cues are present, not only at the time of recall, but also at the time of learning (Tulving and Osler, 1968). This latter finding is in accord with Melton's statement regarding the necessity of the reinstatement of the original stimulus for the retrieval of the response (Melton, 1963). Further support for Melton's notion is found in Martin's work pertaining to the stimulus encoding variability hypothesis (Martin, 1968). Martin

has argued that a stimulus term may be encoded in more than one way (e.g., selecting alternative attributes of a low meaningfulness trigram). Consequently, the portion or aspect of a nominal stimulus that a S perceives and utilizes as the functional stimulus on the first study trial of a paired-associate task may not be the same functional stimulus he perceives and attempts to utilize on the first test trial. If the perceived functional stimulus of the test trial differs from that which was used to form the association with the response on the study trial, the retrieval of the response cannot be effected.

In terms of these considerations of the nature and function of retrieval cues, the major theoretical relevance of investigations into mnemonic techniques appear to lie in the capacity of the previously learned mnemonic cue word schemes to function as invariant retrieval cues for recall. That is, in addition to the facilitory effects of instructions to utilize imaginal mediation, a factor which appears to be responsible for the effectiveness of mnemonic techniques is the set of word cue stimulus terms which are to be used both during learning and at the time of recall. The fact that these terms are well learned prior to their use and that instruction and training are given to form imaginal representations of these cue words suggests that these stimuli are really prepotent "associative hooks" which have the virtue of remaining consistent from study to test trial.

These prepotent "hooks" can be considered to function in at least

two complementary ways. First, the problems of variability of stimulus encoding (Martin, 1968) should be reduced or even nonexistent. Although Martin's hypothesis deals only with the alternative encodings of low meaningfulness (m) stimuli, it is considered here that high m stimuli may also be alternately encoded. A high m word, particularly if it is concrete, may give rise to a verbal or an imaginal code (Paivio, 1969). As long as the code remains consistent from study to test trial, the response may be retrieved. However, in the standard paired-associate situation, it is possible that the code (verbal or imaginal) elicited on the test trial may not be the same code that was elicited and utilized for mediator formation on the study trial. However, an individual using a mnemonic technique has, by virtue of the mnemonic training, encoded and utilized what might be considered to be a set of consistent functional stimuli, namely, the imaginal representations of the stimulus word cues. Hence, the probability that alternative attributes of the stimulus terms (i.e., a verbal code) will supplant such functional stimuli at recall is minimal. In short, mnemonic training provides an individual with a list of relevant functional stimuli which are used for the acquisition of associations with the to-be-recalled words and which are, in Tulving's terminology (Tulving and Pearlstone, 1966) not only available but also readily accessible for retrieval purposes at recall.

The second function of these prepotent "hooks" can be considered to be their role in reducing intralist interference. By design, each word

cue stimulus term of a mnemonic technique is very different from the others. Consequently, no word cue is a strong associate of the other word cues. In addition, the mnemonic instruction regarding a specific imaginal elaboration of the word cue reduces the possibility of the word cue eliciting more than one imaginal representation of it. When applied to a list of to-be-recalled words, these word cues have the capacity to establish a set of interacting images between the word cues and the imaginal representations of the to-be-recalled words which are very different from each other. Hence, intralist interference should be minimized as each mediating image is "unique". In combination with the stability of the functional stimulus from study to test trials, the retrieval of the appropriate mediator should be virtually perfect given that the mediator was formed on the study trial. The only possible source of error, therefore, should be in decoding the image mediator to the appropriate form of the to-be-recalled word. While this has not yet been assessed in the mnemonic task, such errors have been found to occur for the paired-associate task by John Yuille at the University of British Columbia (personal communication). Finally, the fact that a relatively high frequency of intralist errors occurs for a task in which Ss are asked to successively link a series of to-be-recalled words with imaginal mediators (Delin, 1969a; Wood, 1967) suggests that the prepotency of the "hooks" rather than imagery mediation *per se* (and perhaps verbal mediation) is a necessary condition for reducing intralist interference effects in the mnemonic task.

In conclusion, mnemonic techniques are effective in facilitating learning. However, they are not as effective nor as generalizable as professional mnemonists and proponents of commercial memory courses would have us believe. The two factors which have emerged as being primarily responsible for the facilitory effects with concrete words in this investigation are: a previously learned list of word cues which, by virtue of instruction and practice, are consistently utilized for learning and recall; and, instructions to form associative mediators of either a verbal or imaginal nature. Unfortunately, a precise specificiation of how these factors function cannot, at this time, be made. At the risk of belaboring the issue, it appears that the key to a full understanding of the mnemonic technique lies, not only with considerations of the effects of variables found to be important in the paired-associate learning task (Paivio, 1969), but in a determination of how effectively the implicit mnemonic word cue code stimulus terms are utilized to form associative mediators at the time of learning and how such stimulus terms function as retrieval cues at the time of recall.

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APPENDIX A

IMAGERY (I), CONCRETENESS (C), AND MEANINGFULNESS (m) VALUES OF THE 70 CONCRETE AND 70 ABSTRACT NOUNS* UTILIZED IN THE TRAINING AND TEST SESSION LISTS

TRAINING SESSION

List 1

Concrete	I	C	m	Abstract	I	C	m
Letter	6.37	6.94	5.96	Situation	2.53	2.76	4.84
Boy	6.57	6.93	6.96	Opportunity	3.03	2.63	4.08
Lip	6.57	6.93	5.32	Theory	2.57	1.90	5.88
Hall	6.37	6.72	6.16	Excuse	2.77	3.05	4.04
Piano	6.70	6.85	6.40	Necessity	3.00	1.97	5.92
Corner	6.13	6.65	5.67	Custom	3.43	2.99	5.33
Woman	6.70	6.63	6.40	Evidence	3.23	3.45	6.20
Fox	6.73	7.00	7.40	Method	2.63	2.20	5.20
Hammer	6.73	6.96	6.92	Mind	3.03	2.60	5.88
Barrel	6.57	6.94	6.16	Development	3.07	2.82	6.04

mean I = 6.54   mean I = 2.93

mean C = 6.86   mean C = 2.64

mean m = 6.32   mean m = 5.34

* Selected from the Paivio, Yuille, and Madigan (1968) norms for imagery (I), concreteness (C), and meaningfulness (m), of 925 nouns

List 2

	Concrete				Abstract		
	I	C	m		I	C	m
Toy	6.17	6.63	6.96	Freedom	3.83	1.98	6.36
Library	6.73	6.87	6.40	Incident	2.90	3.00	4.16
Student	6.27	6.38	5.96	Fate	2.37	1.46	4.00
Nail	6.50	6.96	6.08	History	3.47	3.03	6.91
Hotel	6.40	6.80	5.96	Comparison	2.93	2.69	4.56
Forehead	6.27	6.93	5.08	Capacity	3.40	2.41	5.44
Bar	6.40	6.83	6.08	Mercy	3.40	1.59	5.20
Child	6.50	6.87	7.04	Attitude	2.77	1.83	5.60
Cord	6.03	6.93	6.00	Impulse	3.70	2.08	4.96
Snake	6.90	7.00	6.88	Memory	3.10	1.78	5.00

mean I = 6.42   mean I = 3.19

mean C = 6.82   mean C = 2.19

mean m = 6.24   mean m = 5.22

TEST SESSION

List 1

	Concrete				Abstract		
	I	C	m		I	C	m
Dollar	6.50	6.62	6.48	Folly	2.93	2.63	4.40
Iron	6.07	6.87	6.12	Idea	2.20	1.42	4.88
Steamer	6.53	6.94	6.32	Belief	2.73	1.55	5.24
Girl	6.87	6.83	5.12	Truth	2.73	1.69	4.78
Arm	6.53	6.96	6.92	Direction	3.83	3.19	6.78
Mule	6.60	6.96	6.12	Explanation	2.90	3.25	5.80
Village	6.50	6.69	5.32	Fact	2.20	3.31	4.29
Candy	6.63	6.56	6.39	Knowledge	2.97	1.56	6.36
Gentleman	6.20	6.42	5.80	Confidence	3.40	1.52	4.17
Doll	6.17	6.94	6.12	Virtue	3.33	1.46	4.87

mean I = 6.46   mean I = 2.92

mean C = 6.78   mean C = 2.16

mean m = 6.07   mean m = 5.16

List 2

Concrete	I	C	m
Dress	6.53	6.93	5.68
Tower	6.53	6.96	6.42
Pole	6.10	6.93	6.20
Garden	6.73	6.83	6.36
Officer	6.23	6.32	5.43
Rock	6.37	6.96	5.96
Cat	6.80	7.00	6.96
Peach	6.60	6.80	6.84
Elbow	6.30	6.94	5.16
Army	6.53	6.55	6.88

mean I = 6.47

mean C = 6.82

mean m = 6.17

Abstract	I	C	m
Instance	2.00	2.87	4.04
Moral	3.17	1.39	6.44
Trouble	3.53	2.25	5.08
Spirit	3.43	1.86	5.72
Fault	2.83	2.87	4.80
Advantage	2.37	2.25	4.48
Advice	3.13	2.08	5.39
Style	3.83	3.18	5.84
Law	3.73	3.23	6.32
Hint	2.37	2.25	4.48

mean I = 3.06

mean C = 2.53

mean m = 5.18

List 3

Concrete	I	C	m
Doctor	6.37	6.59	5.92
Blood	6.70	6.82	6.56
House	6.67	6.93	6.83
Insect	6.10	6.80	6.32
Gold	6.47	6.76	6.36
Priest	6.53	6.59	6.88
Flag	6.60	6.94	6.54
String	6.20	6.90	5.29
Boulder	6.13	6.96	5.88
Factory	6.43	6.87	6.00

mean I = 6.42

mean C = 6.82

mean m = 6.26

Abstract	I	C	m
Origin	2.30	3.25	5.32
Honor	3.50	1.75	5.08
Intellect	2.93	1.83	5.56
Distinction	2.70	2.20	3.80
Amount	2.73	3.62	5.84
Moment	2.50	2.52	4.38
Mood	3.67	1.52	5.36
Effort	3.33	2.22	5.75
Justice	3.60	2.18	6.60
Position	2.97	3.31	6.24

mean I = 3.02

mean C = 2.44

mean m = 5.39

List 4

	Concrete				Abstract		
	I	C	m		I	C	m
Mother	6.67	6.52	5.83	Profession	3.83	3.65	5.44
Frog	6.73	6.96	6.56	Opinion	3.23	2.29	4.96
Arrow	6.57	7.00	6.80	Chance	2.50	1.51	5.61
Skin	6.43	6.96	5.67	Expression	3.57	2.48	6.13
Sugar	6.57	6.96	7.00	Soul	2.13	1.87	6.40
Professor	6.17	6.52	5.40	Length	3.73	3.75	5.84
Engine	6.33	6.76	6.08	Sentiment	3.57	1.83	4.88
Pipe	6.43	6.90	6.20	Quantity	3.47	3.32	4.17
Valley	6.57	6.66	6.56	Ability	2.67	2.03	5.60
Newspaper	6.57	6.56	6.12	Tendency	2.20	1.78	4.08

mean I = 6.50 mean I = 3.09

mean C = 6.78 mean C = 2.45

mean m = 6.22 mean m = 5.31

List 5

	Concrete				Abstract		
	I	C	m		I	C	m
Corn	6.47	6.90	6.96	Thought	2.77	1.28	5.32
Butter	6.57	6.96	6.91	Pledge	3.63	2.93	5.92
Pencil	6.37	7.00	6.48	Majority	3.63	3.48	5.48
Building	6.40	6.94	5.48	Duty	3.17	2.32	5.60
Wife	6.53	6.52	6.48	Occasion	2.53	3.22	5.00
Pepper	6.27	6.96	6.52	Interest	3.13	2.20	5.52
Chin	6.43	6.96	5.28	Welfare	3.17	2.35	6.16
Circle	6.23	6.00	4.88	Quality	3.10	2.13	5.52
Elephant	6.83	7.00	6.88	Hope	3.83	1.18	5.52
Pupil	6.37	6.63	6.24	Cost	3.57	3.41	6.24

mean I = 6.45 mean I = 3.25

mean C = 6.79 mean C = 2.45

mean m = 6.21 mean m = 5.63

APPENDIX B

Post-experimental Questionnaire

Name: ________________

Number: ________________

Please check (√) YES or NO and COMMENT, if necessary.

1. Did you understand all of the instructions in this experiment?

   YES _____ NO _____

   If "NO", which part(s) did you have trouble understanding?

   ____

   ____

   ____

2. Did you hear and understand all of the numbers and words that were presented on the tape recorder as part of the Study and Test Trials?

   YES _____ NO _____

   If "NO", how many numbers and words do you estimate you missed because you were unable to hear them clearly?

   ONE _____ LESS THAN 3 _____ LESS THAN 5 _____ LESS THAN 10 _____

   MORE THAN 10 _____

3. Briefly describe the technique you used in learning the lists of words that were used in the experiment today.

   ____

   ____

   ____

   ____

4. Was this technique the same one you were instructed to use last week?

YES _____ NO _____

If "NO", when did you change (List number) and what were your reasons for changing?

____

____

____

5. Do you think there is a "better" technique than the one you used for learning these word lists?

YES _____ NO _____

If "YES", briefly describe what you think this "better" technique might consist of:

____

____

____

6. Have you ever received training in mnemonic (memory training) methods?

YES _____ NO _____

(a) If "YES", did you study the method while attending:

(1) public school _____

(2) junior college _____

(3) university _____

(4) a commercial memory course _____

(b) If you have read about memory training methods, what source book did you use?

____

____

(c) If you have received training in such a method or have studied one on your own prior to this experiment, how often do you use it?

(1) as often as possible _____

(2) sometimes _____

(3) seldom _____

(4) never _____

(d) Did you attempt to use a previously learned memory technique in this experiment?

YES _____ NO _____

7. Use the following list of adjectives to describe the word lists that you learned and recalled in this experiment. Check those adjectives which best describe these word lists. You may check more than one.

difficult	_____	vivid	_____
funny	_____	concrete	_____
confusing	_____	descriptive	_____
ordinary	_____	long	_____
abstract	_____	meaningful	_____

8. Use the following list of adjectives to indicate your personal evaluation of this experiment. You may check more than one.

interesting	_____	unnecessary	_____
enjoyable	_____	exhausting	_____
boring	_____	relevant	_____
stimulating	_____	useful	_____
dumb	_____	nonsense	_____

9. If you have any comments you would like to make about this experiment, please feel free to make them. Use the back of this page if you need more space.

____

____

____

____

APPENDIX C

Instructions to Subjects

The examples in these instructions are based on concrete to-be-recalled words. The alternate examples for abstract words are presented in an Addendum to this Appendix and are indexed in the text by a series of lower case letters enclosed in parentheses.

General Instructions for All Subjects

Good morning. (Good afternoon.) There are two parts to this experiment. Part 1 will be carried out today and Part 2 will be carried out at the same time and in the same place one week from today. It is very important that you return for Part 2 as the results of Part 1 are of no use to us without the results of Part 2. As you already know, you will be given two credits for serving in this experiment. Your credit cards will be given to you at the end of Part 2. If, for some reason such as illness, you cannot return for Part 2, you will be given one credit for having participated in Part 1 of the experiment.

The experiment is concerned with learning and memory. Please listen carefully to all of the instructions that I will give you, as how well you will do depends on how well you were able to follow the instructions.

Each part of the experiment consists of a number of different

sections. You will be given separate instructions prior to each section so that you will know exactly what you are to do. Please do not hesitate to ask questions if you have any doubt as to what you are to do.

We cannot tell you the purpose of the experiment at this time but you will receive a full explanation as to what we are trying to determine by means of this experiment at the completion of Part 2. It is exceedingly important that you do not describe the details of this experiment to other people who are also taking Psychology 202. The reason for this is that many people must be tested in this experiment and it might happen that any 202 student you might describe this experiment to may eventually serve in it. As you may already know from your Psychology 202 course, a person who has prior knowledge of the test materials and the procedures to be followed may be at an advantage compared with someone who does not have this information. It is this type of thing that can invalidate the results of an experiment. Hence, we ask your co-operation in not passing on the details of this experiment to these people.

To review very briefly, there are two parts to this experiment with each part consisting of a number of different sections. There is a break between each section and the necessary instructions will be given prior to each section. If there is any aspect of the instructions that you do not understand, please ask about it so that you will know exactly what you are to do. This experiment is difficult so do not be discouraged if you do not seem to be doing well.

Just do the best that you can. Do you have any questions at this time?

Training Session Instructions (Lists 1 and 2)

List 1 (All Groups). We are now ready to begin the first section of the experiment. Put your name in the appropriate place on one of the answer sheets that you have in front of you. In the space marked "List Number" write a "1". In a few moments you will be presented with a series of number-word pairs such as "11-dish" (a). That is, you will hear a number which will be immediately followed by a word. A few seconds later you will hear another number followed by another word, and so on until we come to the end of the series. Your task is to learn which word goes with which number so that when the numbers are presented alone you will be able to remember and write down the word that goes with the number. In this case, if you were given the number "11", you would write down the word "dish" on your answer sheet. We will go through the complete list of number-word pairs first. You must concentrate on each pair as it is presented as we will go through the list only once. This is called the study trial. Please do not write anything on your answer sheets during the study trial. After we have completed the study trial, that is, the presentation of all the number-word pairs, you will be presented with only the numbers. This is called the test trial and I will inform you when the test trial is about to begin. Your task is to write down the word that goes with each number as the numbers are presented. Please note that there are

no numbers on your answer sheet. The numbers on the test trial will not be presented in the same order as they were presented on the study trial. As the numbers are presented on the test trial you are to write down the words that go with these numbers in a top-to-bottom order on the answer sheet. That is, the word which goes with the first number that is presented on the test trial, regardless of what that number is, is to be placed in the first space. The word that goes with the second number presented on the test trial, again regardless of what that number is, is to be placed in the second space, and so on. You will have only a short period of time to think of and write down the word that goes with a number so work as quickly as you can. If you cannot remember the word that goes with a number, mark an "X" in that space and go on to the next space when the next number is presented. Are you perfectly clear as to what you are to do on the study and test trials?

All of the number-word pairs for the study trial and all of the numbers for the test trial will be presented via this tape recorder. Once the tape recorder is put into use for the study trial we cannot stop for questions until after the test trial is completed. In other words, please be absolutely sure what you are to do before we start.

In review, you will be presented with a series of number-word pairs and your task is to learn which word goes with which number. Since these pairs will be presented only once it is to your advantage to concentrate on each pair as it is presented. After the present-

ation of the number-word pairs, you will be presented with the numbers alone, in a different order. You are to think of the word that goes with each number as it is presented and to write this word on your answer sheet. Remember, work from top to bottom on the answer sheet. If you think you know the word but are not sure, write it down anyway - it is perfectly all right to guess. If you can't remember a word that goes with a particular number, mark an "X" in the space on the answer sheet and go on to the next space. Do you have any questions? We are now ready to begin the study trial for List 1. I will tell you when the test trial is about to begin. Ready.

Please make sure that your name is on your answer sheet. That was List 1. Check to see that you have placed a "1" in the space labelled "List Number". Set this answer sheet aside and do not write any more words or change anything on it. Take the second answer sheet and put your name on it. You will now have an additional one minute to write down any words that you may have missed on the test trial. It is not necessary to write down the number that a word goes with. It is not necessary to write down the words that you have already put down on the first answer sheet. In fact, you may refer to it if you wish but do not write anything on it. In addition, it is quite all right to guess if you think you know the word but are not sure. Are there any questions? We will begin the one-minute period now and I will tell you when to stop. Ready.

Please make sure that your name is on this answer sheet. In the

space marked "List Number" place a "1" followed by an "A". I will now collect these two answer sheets and also give you two more answer sheets which will be used in the next section of the experiment.

List 2 (Control Groups). Please put your name on one of the answer sheets I have just given to you. This will be List 2 so write a "2" in the space designated "List Number". The instructions for learning the second list are exactly the same as the instructions you followed in learning the first list of words. You will be presented a series of number-word pairs on the study trial and only the numbers, in a different order, on the test trial. All of the words that will be presented are different from the first list of words that you learned. Remember to study each number-word pair as it is presented. Do not write anything on your answer sheet during the study trial. On the test trial, write down the word that goes with each number as these numbers are presented on the tape recorder. Work from top to bottom on the answer sheet and mark an "X" if you cannot remember the word that goes with a number. Do you have any questions? Get ready for the study trial for List 2. I will tell you when the test trial is about to begin. Ready.

That was List 2. Please make sure you have a "2" recorded in the space marked "List Number". Make sure your name is on the answer sheet as well. Set this sheet aside and put your name on the second answer sheet. You will again have one minute to write down any words

that you may have missed on the test trial but remember now. It is not necessary to write down the words that you wrote down during the test trial. We will begin the one-minute period period now.

Please make sure your name is on the answer sheet and that you have a "2A" written in the space labelled "List Number".

For reasons that will be made clear to you at the end of Part 2, we are going to take a 10-minute break before continuing with the next section. Since 10 minutes is not really enough time for you to do any studying, perhaps we can talk about the nature of the University or some other topic you are interested in. We can talk about anything you wish except the experiment itself.

The ten-minute period is now over. For reasons that will be made clear to you at the end of Part 2 of this experiment, we are going to have another study and test trial on List 2, that is, the list you learned 10 minutes ago. The procedure you are to use is exactly the same as before. You will be presented with the number-word pairs on the study trial and you are to try and learn which word goes with which number. On the test trial, you will be presented with only the numbers, in a different order, and you are to write down the word that goes with the number. Remember to work from the top to the bottom of the answer sheet, marking an "X" if you cannot remember the word that goes with a particular number. Please make sure that your name is on the answer sheet. In the space labelled "List Number" write a "2" followed by the word "repeat". Are there any questions?

List 2 (Image-mediation Groups). Please put your name on one of the answer sheets I have just given to you. This will be List 2 so write a "2" in the space designated "List Number". The instructions for learning this list are somewhat different from the instructions for the first list. Instead of number-word pairs, you will be presented with a series of number-cue word-word sequences such as "11-raven-dish" (b). The cue words will assist you in remembering the words that go with a particular number. However, these cue words will help you only if you use them in a particular way. Try to form a mental picture or image using the cue-word and the word to-be-remembered. For example, if the cue word is "raven" and the to-be-remembered word is "dish", you might picture a big black raven flying through the air with a dish in its mouth (c). Or, you might picture someone throwing a dish at a raven which is sitting on a fence (d). Try forming an image for the sequence "12-shelve-diamond" (e). Try and form images for each of the cue words and the to-be-remembered words as the sequences are presented on the study trial.

Now that you understand what you are to do on the study trial, we will consider what you are to do on the test trial. The test trial is similar to that of List 1 except that instead of only being presented with the numbers, you will be presented with the numbers and the word cues. For example, on the test trial you would be presented with "11-raven". The word "raven" should bring to mind the image you formed on the study trial. This will enable you to remember the to-be-remembered word "dish" and this word would be written on the answer

sheet. Please note that it is not necessary to write down the cue word on the test trial. It is only necessary to write down the to-be-remembered word. The procedure here is the same as it was for List 1. That is, the number-cue words will be presented in a different order on the test trial than they were presented on the study trial. Write your answers in a top-to-bottom order on the answer sheet as each number-cue word is presented. If you cannot remember the word that goes with a particular number-cue word, mark an "X" on that line and go to the next line. Again, you will have only a short period of time to remember and write down the word so work as quickly as you can.

Do you understand the instructions? If there are no (further) questions, we will begin the study trial. Remember, you are to form a mental picture or image of the cue words and the to-be-remembered words as they are presented on the study trial so that when you are presented with the number-cue words on the test trial, you will be able to remember and write down the word that was paired with it on the study trial. Ready.

That was List 2. Please make sure that your name is on the answer sheet and that you have "2" recorded in the space marked "List Number". Set this answer sheet aside and put your name on the second answer sheet. As with List 1, you have one minute to write down any words that you may have missed on the test trial but which you now remember. It is not necessary to write down the words that you wrote down during

the test trial. We will begin the one-minute period now. Ready.

Please make sure your name is on this answer sheet. Write a "2A" in the space labelled "List Number".

List 2 (Verbal-mediation Groups). Please put your name on one of the answer sheets I have just given to you. This will be List 2 so write a "2" in the space designated "List Number". The instructions for learning this list are somewhat different from the instructions for the first list. Instead of number-word pairs, you will be presented with a series of number-cue word-word sequences such as "11-raven-dish" (b). The cue words will assist you in remembering the words that go with a particular number. However, these cue words will help you only if you use them in a particular way. Try to form a phrase or sentence using the cue-word and the to-be-remembered word. For example, if the cue word is "raven" and the to-be-remembered word is "dish", you might form a sentence such as, "The raven was playing with the dish" (f). Or you might think of the phrase "a raven in a dish" (g). Try forming a phrase or sentence for the sequence "12-shelve-diamond" (e). Try and form phrases or sentences for each of the cue words and the to-be-remembered words as the sequences are presented on the study trial.

Now that you understand what you are to do on the study trial, we will consider what you are to do on the test trial. The test trial is similar to that of List 1 except that instead of only being presented with the numbers, you will be presented with the numbers and

the word cues. For example, on the test trial you would be presented with "11-raven". The word "raven" should bring to mind the phrase or sentence you formed on the study trial. This will enable you to remember the to-be-remembered word "dish" and this word would be written on the answer sheet. Please note that it is not necessary to write down the cue word on the test trial. It is only necessary to write down the to-be-remembered word. The procedure here is the same as it was for List 1. That is, the number-cue words will be presented in a different order on the test trial. Write your answers in a top-to-bottom order on the answer sheet as each number-cue word is presented. If you cannot remember the word that goes with a particular number-cue word, mark an "X" on that line and go to the next line. Again, you will have only a short period of time to remember and write down the word so work as quickly as you can.

Do you understand the instructions? If there are no (further questions), we will begin the study trial. Remember, you are to form a phrase or sentence linking the cue words and the to-be-remembered words as they are presented on the study trial so that when you are presented with the number-cue words on the test trial, you will be able to write down the word that was paired with it on the study trial. Ready.

That was List 2. Please make sure that your name is on the sheet and that you have a "2" recorded in the space marked "List Number". Set this answer sheet aside and put your name on the second answer

sheet. As with List 1 you have one minute to write down any words that you may have missed on the test trial but which you now remember. It is not necessary to write down the words that you wrote down during the test trial. We will begin the one-minute period now.

Please make sure your name is on this answer sheet. Write a "2A" in the space labelled "List Number".

Training Session Mnemonic Instructions

General Instructions (All Experimental Groups). The method you used in learning the last list of words is part of what is known as a mnemonic technique. The word "mnemonic" is of Grecian origin and means "memory training". Such a technique is supposedly capable of improving a person's memory. For the next few minutes I would like to tell you about these mnemonic techniques and how they are used. Following this, I will give you one of these techniques and will ask you to learn how to use it. It's really very simple and you will be able to learn it very quickly.

The first mnemonic technique was apparently invented by a Greek poet by the name of Simonides. It is said that Simonides invented the technique as a result of a personal experience. Simonides had been invited to a banquet honoring certain Greek athletes. During the course of the banquet, Simonides was called by someone and left the banquet building. While he was outside, the roof of the banquet hall collapsed and killed all of the guests. The damage was so extensive that the

bodies of the guests were mangled beyond all recognition - so much so that not even their relatives could identify them. Simonides, however, knew the names of all the people who were at the banquet and furthermore was able to remember where they had been sitting. As a result he was able to identify them. This suggested to Simonides that a person might devise for himself a series of places in his mind, such as the seats at a banquet table or the rooms in a house (Simonides called these places memory loci), and place the things he wished to remember in these places. When a person wished to remember these things, he simply had to "visit" these places in his mind and he would be able to remember the things that were placed there. Many rules were devised for selecting such places as well as rules for placing the things one wished to remember in these places. The system became popular because the Greeks placed much emphasis on speech making and such a system enabled a person to remember the things he wanted to mention in his speech. Using any sort of written notes was not considered good form at that time.

Many mnemonic techniques are available today. All of them have been derived from Simonides' basic system. You have undoubtedly been in contact with people who use these mnemonic techniques although you were probably not aware of it at the time. Some of the best examples of these techniques in operation come from people who earn their living by entertaining people with their fantastic mental powers. This is usually done by their demonstrating that their memory is much better than yours. A professional mnemonist, as such a person is called,

might do this in the following way. If any of you have seen the Reveen show here in Edmonton, you will recognize this example at once. Anyone in the audience is asked to call out the name of an object (hat, truck, etc.), a telephone number, a licence plate number, a name of a person, a name of a city, and so on. As each person gives an item, it is written on a blackboard by an assistant to the mnemonist. These items are numbered 1, 2, 3 and so on for however many items there are. Suppose that 50 such items are given by the audience. The blackboard is then placed so that only the audience can see it. Sometimes the mnemonist will blindfold himself so that people will not suspect that any sort of mirror tricks are used. The audience is then invited to test the mnemonist's memory by calling out a number of an item or the item itself and ask for the number that it was paired with. Most of us would probably only get 5 to 10 of them correct. The mnemonist gets them all. As a result, most of the audience is convinced of the mental powers of the mnemonist and may, perhaps, be more believing of some of the other things these entertainers do such as hypnosis, illusions, and the like. The "mental power" of these mnemonists is not magical. I hope you won't be disillusioned when I tell you that they do use a mnemonic technique like the one invented by Simonides and that given the technique and practice with it, we could do the same thing as the mnemonist did.

A Russian medical doctor and psychologist, Alexandr Luria, has recently published a report of an individual who used a very elaborate mnemonic technique for remembering things. Luria was able to study

this man, who incidentally earned his living as a mnemonist, for a period of 30 years. This man rarely forgot anything that was presented to him. For example, he could remember perfectly lists of 20 or more nonsense words which were presented to him 15 years earlier. He could memorize extensive passages of foreign language poetry even though he did not understand the meaning of it. He rarely forgot the name of a person even though he was introduced to thousands of people in the course of his work. Individuals such as this are, of course, rare. However, the important point is that he did use a mnemonic technique to memorize things he wished to remember.

My own memory is certainly not exceptional. However, by using one of these mnemonic techniques I have been able to quickly memorize and remember without error about 30 items. Recently I was being interviewed for a job by a Canadian university and during the course of my day's visit there I met about 25 of the faculty in their Department of Psychology. Since these people would be deciding whether or not they would hire me, I felt that it would be in my best interests to remember their names as I was introduced to them. I used one of the mnemonic techniques to do this and, somewhat to my surprise and pleasure, I was able to remember their names when I again met them later that evening. Whether or not I'll get the job, I don't know. However, being able to correctly recall the names of the faculty members did give me a certain sense of confidence and undoubtedly saved me much embarrassment had I not called a person by his right name.

As I mentioned earlier, I am going to ask you to learn one of these

mnemonic techniques. Because of time limitations, I can only present you with the basic principles and how to use them. However, if you are interested in pursuing the technique after this experiment is over, the basic principles you will learn here will allow you to develop it on your own.

(Because of very basic similarities among the techniques, only the instructions for the hook-image and the rhyme-verbal mnemonic techniques are presented here. The instructions for the other groups are available from the author on request.)

Hook Mnemonic Technique - Image Mediation.

Part of a mnemonic technique consists of a series of cue words which are used to form mental pictures or images with the to-be-remembered words. You have already used these cue words on List 2 but it is now necessary to memorize them. The reason for this is that when you use a mnemonic technique to learn a list of items, you must provide these cue words for yourself. I will first put the list of numbers and the cue words that go with them on the blackboard. Then I will tell you how to use them. Following this, we will spend some time memorizing this list of cue words.

1 - t - tea
2 - n - Noah
3 - m - May
4 - r - ray
5 - L - law
6 - j - jaw
7 - k - key
8 - f - free
9 - b - bay
10 - t,s - toes

To learn this list, think of the following. One (1) brings to mind

the letter "t" because both have a similar downstroke. When you think of the word "tea" you should picture in your "mind's eye" a teacup (sketched on blackboard) in which you can put the item you want to remember. For example, suppose the first thing you want to remember is "toy" (h). You would think of the word "tea", get the image of the teacup and picture for yourself a toy soldier marching around inside the teacup (sketched on blackboard) (i). Close your eyes and picture this in your mind. Got it? You may open your eyes. When you want to remember the word "toy", you would say to yourself "1" which would bring to mind the letter "t", the word "tea" and the image of the teacup with the toy soldier marching around inside it. Hence, you will be able to remember the word "toy". Simple, isn't it?

You are to do the same type of thing with each one of these number-letter-word cues when you are learning a list of words. That is, when you hear the number, think of the cue word that goes with it. This will bring to mind the mental picture you have of this cue word. The to-be-remembered word is linked to this mental picture, just like in the example we have just gone over. The mental pictures you form of the cue words and the to-be-remembered words may be unusual, funny, or bizarre. In fact, the technique seems to be more effective if you try to do this. After all, have you ever really seen a toy soldier marching around inside a teacup?

Let's go over the remaining number-cue words and the mental pictures you should form of these cue words. Two (2) is "n" because if

you turn an "n" on its side, it sort of looks like a "2". The "n" brings to mind the word "Noah" and you should picture for yourself Noah's ark (sketched on blackboard - as were all subsequent pictorial representations). The things you want to remember for this number will be put in or on Noah's ark. Three (3) is "m" because if you turn a "3" on its side it looks like an "m". The letter "m" brings to mind the word "May" which is the name of a month. May signifies springtime and you've all heard of a "maypole". Picture this maypole in your mind and place the things you want to remember on the swinging ropes of the maypole. Four (4) is "r" because the words "fore", "four" and "for" all have an "r" in them. The letter "r" signifies the word "ray" and you should think of the ray of light from a flashlight. Pretend you are in a dark room and that you have turned the flashlight you are holding in your hand on. See the circle of light the ray makes on the table. Put the things you want to remember inside the circle of light on the table. Five (5) is "L" because in Roman numerals the letter "L" represents the number 50. In Arabic numerals the number 50 has a "5" as the first digit. The "L" brings to mind the word "law". Picture in your mind a policeman holding up his hand to stop traffic. See how the palm of his hand and his thumb form an "L". Place the things you want to remember in relation to the policeman - in his hand, hanging on him, or around him. Six (6) is "j" because if you turn a "6" upside down and have the tail going the other way, it looks like a "j". The letter "j" brings to mind the word "jaw". Picture the jaws of an animal or even a person in your

mind. Put the things you wish to remember between these jaws. Now, only four more items to go. Seven (7) is "k" because in the initial stroke of the letter "k" in formal script the "k" looks like a "7". The letter "k" is the first letter of the word "key". Picture a gigantic key in your mind. Hang the things you wish to remember on this key. Eight (8) is "f". This is kind of a funny one. The word that goes with the "f" is "fee". A doctor charges a fee for his services. Picture yourself in a doctor's office writing a cheque to pay your bill. See the two little zeros you put after the dollar amount? Put them together and rotate them 90 degrees. See? It looks like an "8". Hence, "8" is "f" and the word "fee". "Fee" should bring to mind the doctor's office. Place the things you wish to remember in the doctor's office. Nine (9) is "b" because if you rotate a "9" one-hundred and eight degrees it forms a "b". The letter "b" brings to mind the word "bay". Think of an ocean bay. See the water and the sandy beaches. Picture the things you want to remember floating in the water. Finally, ten (10) brings to mind the letters "t" and "s". Remember from before that "1" is "t"? The letter "s" is used for "0". The word formed from these two letters is "toes". That should be easy to remember because you also have 10 toes. Picture somebody's big feet with 10 toes. Hang the things you wish to remember on the toes. That's it. Do you have any questions about the numbers, letters, words, and the images of the words you are to form? Be sure you understand completely what is involved here. If there are no (further) questions

you may begin memorizing this list of number-letter-word cues. As you memorize them, think of the things I have told you and form the image of each cue word in your mind.

When you think you have the list memorized, write it out in ascending order on the first page of this response booklet. Try to do it without looking at the blackboard. If you missed any, study them until you can repeat the entire list correctly.

I think everyone is finished now. Miss X, what word goes with number 8? Mr. Y, what number goes with the word "ray"? (This procedure continued until all items had been covered.)

We are now going to have a series of tests on these items. That is, the numbers 1 - 10 will be presented in a random order on the tape recorder. Your task is to write down the cue words that go with these numbers - the words you have just memorized. Do not write down any of the words you may remember from the lists you learned before we started working on the mnemonic technique. Just write down the cue word that goes with the number as each number is presented. Work from top to bottom on the answer sheet. Mark an "X" in the space if you cannot remember the cue word that goes with the number. Work quickly because the numbers will be presented quite rapidly. Think of the image you have formed in your mind for each word as you write each word down. Ready.

The correct answers were: 3 - May, 9 - bay, etc. (procedure

repeated for three more trials). Please make sure your name is on the first page of your answer booklet. Where it says "List Number" write the word "Practice". I am now going to pick up these answer booklets and give you one more answer sheet.

In order to get a bit more practice with this technique, the words from the second list you learned today will be presented again. That is, a number will be presented followed by the word you are to remember. The cue words will not be presented this time, however. When you hear the number, think of the cue word that goes with it. This should bring to mind the image you have of it. Then, take the word you are to remember and work it into this image. Remember the toy soldier marching around inside the teacup? Do this for all items that are presented. Then, only the numbers will be presented on the test trial and you are to write down the word that goes with the number - the word you are learning on the study trial. It is not necessary to write down the cue word. When you hear the number on the test trial, think of the cue word. This will bring to mind the image you have of it. It will also bring to mind the word you are to remember. This is the word you are to write down. Do you understand what you are to do? Any questions? Ready.

Please make sure your name is on the answer sheet. Write "Practice" in the space labelled "List Number".

Rhyme Mnemonic - Verbal Mediation.

Part of a mnemonic technique consists of a series of cue words which are used to form phrases or sentences with the to-be-remembered words. You have already used these cue words on List 2 but it is now necessary to memorize them. The reason for this is that when you use a mnemonic technique to learn a list of items, you must provide those cue words yourself. I will now put the list of cue words on the blackboard. Then I will tell you how to use them. Following this we take some time to memorize this list of cue words.

1 - bun
2 - shoe
3 - tree
4 - door
5 - hive
6 - sticks
7 - heaven
8 - gate
9 - line
10 - hen

When using this technique, the procedure is essentially the same as for List 2 except that you will have to provide the cue word yourself instead of having it presented to you. Suppose that the first word you want to learn is "toy" (h). Think of the word that goes with the number 1 - the word is "bun". Form a phrase or sentence which links the word "bun" and the to-be-remembered word "toy". For example, you might think of something like "a hamburger bun is not a toy" or "the bun and toy could not be eaten" (j). It does not matter if your phrases or sentences are funny or ludicrous. In fact, the technique seems to be more effective if you use it this way. Let's consider another example.

Suppose the second word you are to learn is "library" (k). The cue word that goes with the number 2 is "shoe". Form a phrase or sentence linking "shoe" and "library". For example, "he lost his shoe in the library" (l). See how easy it is.

When you wish to recall the words all you have to do is think of the numbers. Each number will bring to mind the cue word that goes with it and the phrase or sentence you formed when you were studying the items. This will help you to remember the word that you wanted. Any questions on this?

Before you can use this technique, however, you must memorize this number - rhyme word system, the one that is on the blackboard. It is very easy because the words rhyme with the numbers. (The instructions from this point on were essentially the same as for the hook mnemonic technique described above.)

End of Training Session Instructions (All Groups). This brings us to the end of the first session. The second session will be held in this same room at the same time next week. Even though you will undoubtedly remember to come, we will telephone to remind you of the time for the second session the night before. This is just standard procedure because people sometimes do forget. After all, you probably have many more things to think about than this experiment. As I mentioned at the beginning of this session, I would appreciate it if you did not discuss this experiment with your friends in Psychology 202 as they may also be serving in this experiment. Thank you very

much for your co-operation today and I will see you at the same time and same place next week.

Test Session Instructions

General Instructions (All Groups). There are three separate sections to today's experiment and I will give you detailed instructions prior to each section. Please ask questions if there is any aspect of the instructions that you do not understand. This experiment is difficult so do not be discouraged if you do not seem to be doing well. Just do the best that you can.

Immediate Recall Tests (Control Groups). Last week you learned and recalled two lists of number-word pairs. The first session today consists of learning a number of such lists, one after the other, following the same procedures which you used last week. That is, on the study trial you will be presented with a series of number-word pairs. Your task is to learn which word goes with which number. On the test trial you will be presented with only the numbers and you are to recall and write down the words that go with the numbers. The numbers will be presented in a different order than they were on the study trial. The words are to be written in a top-to-bottom order on the answer sheet. Please mark an "X" in the space if you cannot remember the word that goes with a number. The number-word pairs on the study trial and the numbers on the test trial will be presented quite rapidly so you will have to work as quickly as you can. Do not write anything on your answer sheet on the study trial. I will tell you when the test trial

is about to begin. Do you have any questions as to what you are to do? Ready.

(Following the test trial a one-minute subsequent recall period was given, following the same procedures as for List 1 and 2 of the Training session. No further instructions were given for this section of the experiment. Four more study-test trials and subsequent recall periods were administered in this section, following the procedures described above.)

Immediate Recall Tests (Experimental Groups). Last week you learned a memory technique to assist you in learning a list of number-word pairs. The first section of today's experiment consists of using this same technique to learn a series of lists, one after the other, following the same procedures that you used last week. First, however, it is necessary that we check to see that you know the mnemonic cue words that you are to use and how to use them. Just to refresh your memory, here is the number cue word system that you used last week (placed on blackboard, reviewed verbally, then erased). The numbers 1 - 10 will now be presented in a random order on the tape recorder. Please write down the cue word that goes with the number as the numbers are presented. Write these cue words in a top-to-bottom order on the answer sheet. Mark an "X" in the space if you cannot remember the cue word that goes with a number. Work quickly as the numbers will be presented at a fairly rapid rate. Ready.

The cue words that go with these numbers are: (appropriate

cue words given). Please make sure that your name is in the appropriate space. Where it says "List Number", write the word "Practice".

I would now like to briefly review how you are to use this technique. (A condensed version of condition-appropriate instructions from the Training session were then given. This was followed by the five study-test trials and subsequent recall periods for the five Test session lists. The procedures were the same as those described above for the control groups.)

Final Recall Test Instructions (All Groups). I now want you to recall all of the words that you learned today. These words are to be written on the answer sheet that I have just given you. Please put your name on the sheets in the space provided. You learned five lists today. The column headings on the answer sheet correspond to the list numbers that were given to today's lists. The spaces in each column are numbered 1 - 10, one space for each word that was in each list. Try to recall the words that occurred in each list and write each word opposite the number that it was paired with in each list. You do not have to recall the lists or the words in each list in any particular order - just try to get the words that you remember in the correct list and paired with the correct number in that list. Do you understand the instructions? It is very important that you try to get the words you remember in the correct column, that is, the number of the list they occurred on today, and with the appropriate number in the list. If you think you know where a word goes, that is, in which

list and with which number, but are not sure, put it down anyway. It is perfectly all right to guess. Do you have any questions? There are 10 minutes allowed for this task. I will tell you when to stop. Ready.

Post-experimental Questionnaire Instructions (All Groups). The final section of this experiment is a short one. It consists of a short questionnaire pertaining to this experiment. I would like you to fill it out at this time. Please answer the questions as carefully as you can as your answers will help us determine whether or not this experiment is really getting at the problems we are interested in. Before you start, please write your name and student number in the spaces provided. When you have finished the questionnaire, I will answer any questions that you have and describe what the purpose of this experiment was.

ADDENDUM TO APPENDIX C

The following words and examples were incorporated into the Instructions to Subjects (Appendix C) for the groups tested on abstract words. The small case letters refer to the places in the text of Appendix C where these words and examples were inserted.

(a) 11 - tragedy

(b) 11 - raven - tragedy

(c) Picture to yourself a big black raven flying through the air. He flies into a power line and is electrocuted. See the feathers drifting down. Certainly this is a tragedy for the raven.

(d) Picture a raven sitting on a coffin in a cemetery. The coffin contains the body of someone who met with a tragedy - perhaps an automobile accident.

(e) 12 - shelve - nonsense

(f) In one of Edgar Allen Poe's poems, tragedy follows a visit by a raven.

(g) That raven was a tragedy.

(h) freedom

(i) One book that refers very often to freedom is the bible. Picture in your mind a Bible placed in the teacup.

(j) A hamburger bun is not sufficient for people who desire freedom.

(k) incident

(l) The lost shoe created an international incident.

APPENDIX D

Tabulated Values for Data Points

for Figures 1-5 of Chapter 3

TABLE D-1

MEAN TEST SESSION STR SCORES FOR EACH GROUP ON EACH LIST

Group	List				
	1	2	3	4	5
SC-C	7.15	5.90	6.00	6.95	6.10
RV-C	8.45	7.80	7.35	7.45	7.95
RM-C	8.25	8.05	8.10	7.70	8.20
HM-C	8.20	7.90	8.25	8.00	7.95
SM-C	7.30	7.40	6.95	7.55	6.55
SC-A	4.15	4.50	4.20	4.40	4.10
RV-A	4.70	5.15	5.30	5.45	5.70
RM-A	6.00	5.15	5.10	4.20	4.75
HM-A	5.80	5.15	5.20	5.85	5.95
SM-A	5.40	4.55	4.65	5.05	5.30

TABLE D-2

MEAN TEST SESSION LBR SCORES FOR EACH GROUP ON EACH LIST

Group	List				
	1	2	3	4	5
SC-C	8.20	7.80	7.30	7.75	7.70
RV-C	8.70	8.25	7.65	7.90	8.45
RM-C	8.55	8.20	8.50	8.15	8.60
HM-C	8.65	8.75	8.60	8.75	9.00
SM-C	8.15	8.10	7.65	8.20	7.60
SC-A	6.05	5.50	5.10	5.35	5.60
RV-A	6.25	5.80	5.95	6.05	6.30
RM-A	6.65	5.75	5.80	4.95	5.60
HM-A	6.65	5.75	6.05	6.60	6.30
SM-A	6.25	5.40	5.60	5.90	6.15

TABLE D-3

MEAN FINAL RECALL TEST STR RATIO SCORES
FOR EACH GROUP ON EACH LIST

Group	List				
	1	2	3	4	5
SC-C	.16	.23	.34	.48	1.16
RV-C	.29	.22	.37	.55	.99
RM-C	.23	.26	.37	.57	.95
HM-C	.25	.22	.47	.65	1.09
SM-C	.35	.30	.45	.67	.98
SC-A	.10	.10	.17	.42	.79
RV-A	.13	.08	.23	.49	.79
RM-A	.07	.21	.28	.44	.92
HM-A	.09	.14	.27	.47	.85
SM-A	.14	.25	.32	.45	.87

TABLE D-4

MEAN FINAL RECALL TEST LBR RATIO SCORES
FOR EACH GROUP ON EACH LIST

Group	List				
	1	2	3	4	5
SC-C	.22	.17	.33	.55	.95
RV-C	.29	.20	.39	.53	.92
RM-C	.23	.26	.36	.55	.87
HM-C	.25	.24	.46	.65	.93
SM-C	.33	.30	.43	.63	.85
SC-A	.11	.09	.18	.45	.74
RV-A	.08	.09	.25	.48	.74
RM-A	.11	.21	.26	.35	.81
HM-A	.12	.14	.25	.49	.83
SM-A	.18	.25	.37	.56	.86

APPENDIX E

Summary Tables of Multiple Range Tests

TABLE E-1

DUNCAN'S NEW MULTIPLE RANGE TEST APPLIED TO LIST 2 STR SCORES*

Groups	SC-A	SC-C	RV-A	RM-A	HM-A	SM-A	SM-C	RV-C	HM-C	RM-C
Means	3.40	4.95	5.15	5.50	5.75	6.75	8.30	8.75	8.95	9.35

* Any two means underscored by the same line are not significantly different at the .01 level of probability ($S_{\bar{x}}$ = .44).

TABLE E-2

DUNCAN'S NEW MULTIPLE RANGE TEST APPLIED TO LIST 2 LBR SCORES*

Groups	SC-A	RV-A	RM-A	HM-A	SC-C	SM-A	RV-C	SM-C	RM-C	HM-C
Means	4.70	5.80	5.90	6.20	6.80	7.20	8.95	9.05	9.20	9.25

* $S_{\bar{x}}$ = .40

TABLE E-3

DUNCAN'S NEW MULTIPLE RANGE TEST
APPLIED TO TOTAL TEST SESSION STR SCORES*

Groups	SC-A	SM-A	RM-A	RV-A	HM-A	SC-C	SM-C	RV-C	RM-C	HM-C
Means	21.35	24.95	25.20	26.30	27.95	32.10	35.75	39.00	40.30	40.30

* $S_{\bar{x}} = 1.70$

TABLE E-4

DUNCAN'S NEW MULTIPLE RANGE TEST
APPLIED TO TOTAL TEST SESSION LBR SCORES*

Groups	SC-A	RM-A	SM-A	RV-A	HM-A	SC-C	SM-C	RV-C	RM-C	HM-C
Means	27.60	28.75	29.30	30.35	31.35	38.75	39.70	40.95	42.00	43.75

* $S_{\bar{x}} = 1.33$

TABLE E-5

DUNCAN'S NEW MULTIPLE RANGE TEST
APPLIED TO FINAL RECALL TEST LBR RATIO SCORES*

Groups	SC-A	RV-A	RM-A	HM-A	SC-C	SM-A	RM-C	RV-C	HM-C	SM-C
Means	156.50	164.80	173.10	182.30	221.45	225.50	227.15	233.55	252.55	254.70

* $S_{\bar{x}} = 11.98$

TABLE E-6

DUNCAN'S NEW MULTIPLE RANGE TEST
APPLIED TO FINAL RECALL TEST STR RATIO SCORES*

Groups	SC-A	RV-A	HM-A	RM-A	SM-A	SC-C	RM-C	RV-C	HM-C	SM-C
Means	156.55	172.40	180.40	191.70	203.15	237.05	237.95	241.35	268.20	275.30

* $S_{\bar{x}} = 15.98$